SCIENCE TEACHER'S WORLD

Teacher's edition of Science World • September 23, 1959

Starting a Science Club

By Dr. Morris Meister
President, Bronx Community College, New York City

AS a sponsor, you should make your enthusiasm constitute the first step in starting a science club. The second step should be an informal meeting of all persons interested in forming a club. You, or an outstanding pupil, may act as chairman of the meeting, at which you tell the group about different activities and varied programs that a science club may undertake. Before taking steps toward organization, encourage free discussion, and make certain the group realizes the value of a science club and wishes to start one.

Outline different kinds of science clubs. Ask the group if it wishes to organize a "general" science club or to restrict activities to a special field.

As the third step, ask the group to consider the need of a constitution. Every science club should have a permanent organization, including a well-drawn constitution. After having decided on the type of club, the pupils may begin to frame a constitution.

Insuring Vitality

Discussion helps to crystallize the aims of a club. Decide what you, as sponsor, hope to accomplish with the group, and what your science club should mean in the lives of the members. How best can you cultivate careful working techniques, proper scientific attitudes and high levels of achievement?

To guarantee high standards of work, a club should restrict its size but have sufficient members to give the stimulation of numbers. A club with diverse interests may have from ten to twenty-five members, rarely more.

The group should establish qualifications for membership. The secretary of the club should receive written applications for membership and should investigate the eligibility of each candidate.

The caliber of the officers helps to assure the success of a club. In addition to the usual officers—a president, a vice-president, a secretary and a treasurer—a club should have a librarian, a curator and a scout. A librarian has complete charge of books belonging to the club and keeps on the alert for possible new purchases, and for loans from the school or from the local library. A curator is responsible for the storage and care of all equipment and apparatus belonging to the club. A scout investigates places for excursions and makes necessary arrangements for them. Excursions may include the whole group or merely small sections, depending upon places to be visited and general purposes of the trips.

The club should meet regularly at the convenience of members and of the sponsor. In general, meetings should occur after school hours in the club workroom. Special evening meetings or all-day Saturday trips help to sustain interest and enthusiasm.

The vitality of a club depends primarily upon careful planning and executing of each activity. Business meetings, though important, should be brief. A committee appointed by the president, or the officers of the club, should plan club programs and consult the club sponsor about them.

The secretary should keep a careful record of meetings. Such a record, particularly a record of demonstration meetings, has great value for subsequent programs.

A club should not overlook the importance of publicity. A special committee should announce all club activities and arrange for adequate publicity on bulletin boards in the high school, in news articles for the school and local papers and through other available channels.

Science Club Meetings

In order to insure balance in the activities of science clubs, sponsors and members should consider carefully different types of meetings that have interest and value.

Lectures—Club sponsors, club members, visiting speakers or former club members may lecture before clubs. The list of guest speakers might include a sponsor, a classroom teacher, a professor or an instructor from a neighborhood college, or advanced students.

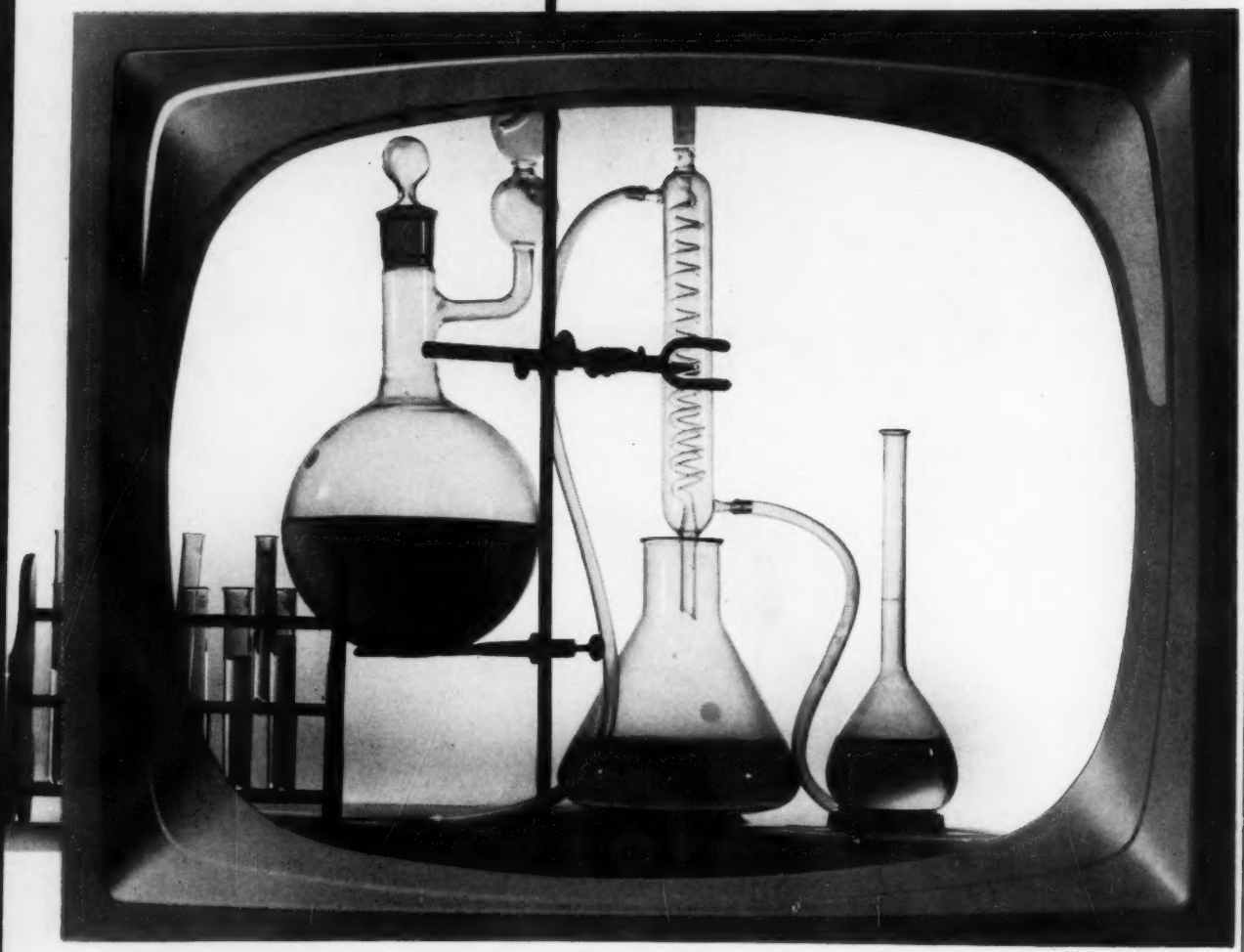
Many persons in a community have interesting information to contribute to science clubs. Local industrial plants have engineers, foremen, and officers who will interest students in the application of science and engineering to daily life.

Museums, zoos, parks, botanical gardens, aquariums, planetaria, libraries, foundations, arboretums, city health departments, electric and gas plants, factories and laboratories offer excellent sources for developing lecture programs. Adults who have organized hobby clubs – microscopists, photographers, mineralogists, geologists and other outdoor enthusiasts—have stimulating material to offer.

Demonstrations – Generally, demonstrations make more vital appeal to members than do lectures. Educational institutions will suggest lecturers who are skillful demonstrators.

Trips and Excursions—Trips to nearby points of scientific interest prove

(Continued on page 3-T)



Enroll now in the first nation-wide television chemistry course for college credit! In color.

On September 28th, the award-winning educational television program, "Continental Classroom," begins its second year on the NBC Television Network with a new two-semester college-level course in Modern Chemistry. Produced in cooperation with The American Association of Colleges for Teacher Education and the American Chemical Society, it will be televised in color, Monday through Friday, from 6:30 to 7:00 am local time. Dr. John F. Baxter, professor of chemistry at the University of Florida, will teach the course. Nobel Prize-winning chemists and other famous scientists will be guest lecturers. In addition to the new 160 lecture-demonstrations in chemistry, last year's Atomic Age Physics course will be repeated Monday through Friday, 6:00 to 6:30 am. Continental Classroom is being made possible through the co-operation of Bell Telephone System, E. I. du Pont de Nemours & Co., The Ford Foundation, General Foods Fund, International Business Machines, Minnesota Mining & Manufacturing Company, The Pittsburgh Plate Glass Foundation, Radio Corporation of America, Standard Oil Company of California, Union Carbide Corporation, and United States Steel.

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West Virginia State College, Institute
Marshall College, Huntington
WISCONSIN
Beloit College

A textbook, entitled "Modern Chemistry," and a study guide have been especially written for this new course. Copies may be obtained through local bookstores or from Prentice-Hall Inc., Englewood Cliffs, N. J.

Starting a Science Club

(Continued from page 1-T)

popular with members and valuable in developing a club program. These trips may include the whole group or selected individuals who will make reports to the club at a later meeting. The scout should gather information constantly, arrange details and report his progress to the club at frequent intervals. He should make definite appointments with persons who will serve as guides on trips. He should arrange for transportation and plan the time of departure and the place of meeting. The success of a field trip depends largely upon the scout's preliminary work. After the trip, members of the club should evaluate the results through informal discussion, comments and suggestions.

Work Periods—These periods represent free time when individuals may develop their particular interests. Each pupil or group may experiment to learn more about use of materials and development of scientific techniques.

Social Functions — Social occasions help to create a friendly spirit among members of a science club. A popular social function is an annual luncheon, with a local or a visiting scientist as a guest of honor.

Exhibits—A small group in a science club may help all the members or a committee to prepare exhibits. A science exhibit should have unity, artistry, force, and, above all, meaning. It must be accurate, thorough, and concise.

Workshop Courses—Practical courses offer excellent means of drawing upon the help of experts from industrial and educational institutions. In such courses, experts give small groups of club members opportunity to see actual work in science and in research and to try their hands at simple techniques. In this way, students come into contact with workers and with procedures in aerodynamics, biology, chemistry and mineralogy.

Organization of a workshop course might result from the combined efforts of several science clubs.

Competitive Programs—A club may plan a competitive program as an intra-club activity, or as an interclub activity, i.e., developing a science fair, competition in writing or other procedures suggested by participating groups. Intra-club competition stimulates by offering prizes to members who develop the best techniques and to members who show the most originality.

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Using *Science World* in Your Teaching

New Uses for Old Elements (pp. 9-11)

General Science Topics: The chemistry of common things, elements and compounds.

Chemistry Topics: The periodic table; the discovery, properties, and uses of oxygen, boron, hydrogen, uranium, silicon, germanium, tantalum, niobium; the history of chemistry.

Physics Topic: Ultra-low temperature phenomena.

About This Article

Dr. Azimov relates how chemical elements known to chemists for many years, some only as laboratory curiosities, have come into new uses that are providing the power and means of control for modern rockets and are providing devices for transmitting and storing information gathered by artificial satellites orbiting the Earth. Some of these elements—for example, oxygen and hydrogen—are quite familiar; others, like niobium and tantalum, are less so.

The article names the discoverer and gives the dates of discovery of oxygen, hydrogen, boron, uranium, silicon, germanium, tantalum, and niobium. The author states the early uses of these elements in medicine and in industry, then goes on to describe how the ingenuity of man has put them to *new* uses in the development of rocket engines, atomic power plants, solar batteries, transistors, and the cryotron. Thus, many of the improvements in rocket engines and computers represent "new uses for old elements"—the end of which is nowhere in sight.

Teaching Suggestions

With a chemistry class this article could well be the subject of a lesson when the periodic table of the elements is studied. The article could be assigned as homework reading in advance of the lesson. Individual students might be assigned to report on the discovery, past uses and the present uses of each of the eight elements described. In the summary, the following points might be emphasized, and for each point specific illustration from the article elicited:

1. Scientific discovery is international in scope.

2. The periodic table enabled chemists to predict the existence of some elements before these were actually discovered and even to predict some of

the properties the elements would have.

3. Further new uses for old elements will probably be discovered—who knows—perhaps by some member of this chemistry class.

In physics classes, the article might be read and discussed with profit, the emphasis being not so much on the elements described, as on the applications made of them—the cryotron, the transistor, computers, the solar battery, atomic reactors, and rocket engines.

Project Saturn (pp. 12-13)

General Science Topic: The space age.
Physics Topic: Laws of motion.
Chemistry Topics: Oxidation, organic compounds, chemical energy.
Biology Topic: Introduction to space biology.

About This Article

To those who marvel at modern rockets and Earth satellites—and who of us does not marvel at them?—Dr. Willy Ley's article comes to say, "You haven't seen anything yet." He describes some of the current developments in rocketry that he witnessed at Redstone Arsenal in Alabama and in California.

In "Project Saturn," engines are being developed to yield a take-off thrust of 1½ million pounds when clustered, that will launch and steer a rocket together with its formidable payload free of the Earth's gravity and into outer space. Achievement of such a feat involves new engine designs, new engine-assemblies, new fuels, and new methods of firing them.

Dr. Ley's article can be useful to the science teacher in the following ways:

1. For the Science Club: as a special report on recent developments in rocketry.
2. For the General Science Class: as enrichment in study of "The Space Age."
3. For the Physics Class: as "applications" of Newton's laws of motion.
4. For the Chemistry Class: as "applications" in the study of oxidation, organic compounds, and chemical energy.
5. For the Biology Class: as an introduction to biological problems of space travel.

Questions for Discussion

1. What is "Project Saturn"?
2. What is the difference between a rocket motor and a rocket engine?
3. What is there "special" about the rocket engine used in Project Saturn?
4. Describe the special way in which fuel is ignited in Project Saturn.
5. Describe the arrangement of the eight engines in Project Saturn.
6. Describe how the rocket in Project Saturn is steered.
7. How does the work in California give promise of even more powerful thrusts than are being developed in Alabama?

Tomorrow's Scientists (pp. 23-26)

Robert Schooley learned that Washington, D. C., his own city, was not included among ten cities in which the U.S. Department of Health, Education, and Welfare was testing milk for radioactivity in relation to atomic fall-out. He therefore decided to conduct such tests of milk in Washington, D. C., for himself. His report describes, in great detail and with admirable clarity, his purpose, his techniques, his apparatus, his data, and his conclusions.

The teacher might well hold up this report as representing an exemplary student-research project. In fact, some students could be stimulated to use the techniques described to make similar studies of milk in their own cities.

The report could be used as assigned reading, too. Biology students might read it in relation to its radiobiology content, physics students in relation to the electronic intsrumentation involved in the project, and chemistry students in relation to the chemical analysis.

Mountains in Motion (pp. 14-15)

Earth Science Topic: Earthquakes.
Physics Topic: Seismography.

Review Questions

1. Describe some of the geological changes brought about by the earthquake in Montana last summer.
2. Explain why sudden breaks occur along lines of weakness ("faults").
3. Describe a theory to explain why an earthquake takes place.
4. Describe three types of shock waves produced by quakes.
5. Describe how seismologists determine the exact location of a quake.
6. What geographic regions are included in the "earthquake belts"?
7. Describe the relationship between an earthquake and a tidal wave.

Working Current News Into the Science Classroom

What can the inclusion of appropriate current news contribute to science learning in the classroom?

It can expand a student's span of interest in his reading of periodicals. It can impress upon the student the fact that science is a continuous process of search and discovery. It can widen the scope of a student's conception of the range of vocational opportunities within the field of science he is studying. It can enhance a sense of reality about what he reads in the textbook and learns in his science lessons.

Recognizing these values, science teachers have developed a variety of ways of "handling" current news in their classes. What are some of these methods?

A current news item can be used to motivate or introduce a lesson when the event happily coincides with the topic of the lesson.

Current news can be used as "applications" of principles studied in a science lesson.

Some teachers set aside a few minutes at the beginning of each period for students to report to the class on current news related to the subject. Other teachers set aside a period every week or every two weeks for this purpose.

Students can be encouraged to maintain a scrapbook of clippings on current news in science, or they may be persuaded to work into their notebooks a "division" on science in the news.

Many teachers maintain—with assistance of a student squad—an attractive bulletin board of clippings, pictures and the like emphasizing current happenings in science related to the course of study.

To contribute to your teaching of current news—whatever methods you use—*Science World* maintains, as a regular feature, *Science in the News*. Items treated are elaborated and illustrated. The editor would be happy to hear from science teachers who have developed effective ways of using this feature with their classes.

—Zachariah Subarsky

At the Edge of Life (pp. 6-8)

General Science Topic: Scientific method.
Biology Topics: Classification of organisms, evolution, one-celled organisms.

About This Article

After a description of the characteristics which type an organism as a plant or animal, the article discusses the phylum Protozoa. The class Flagellata is taken up in detail because of difficulties biologists encounter when attempting to classify some members of this class.

Plant-like flagellates—euglena and chrysamoeba – and animal-like flagellates – trypanosomes and collar-flagellates – are described. The student is introduced to these organisms, which are in the transitional zone of life and show the characteristics of both plants and animals.

The student is led to realize that

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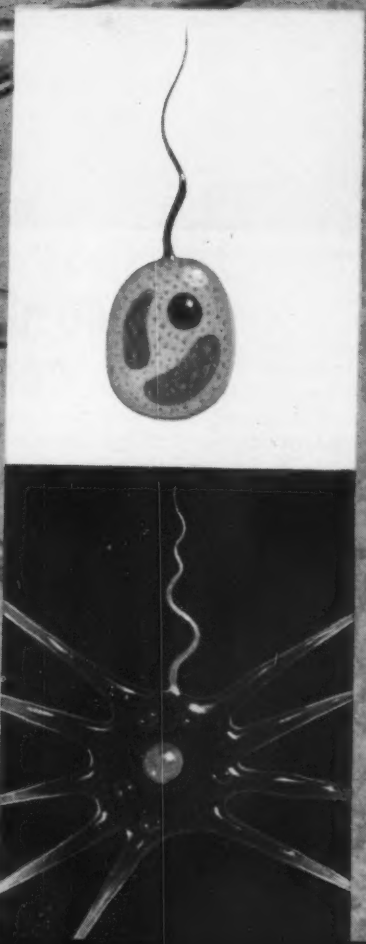
At the Edge of Life

SEE PAGE 6



The Chrysamoeba . . .
It Lives in Two Worlds

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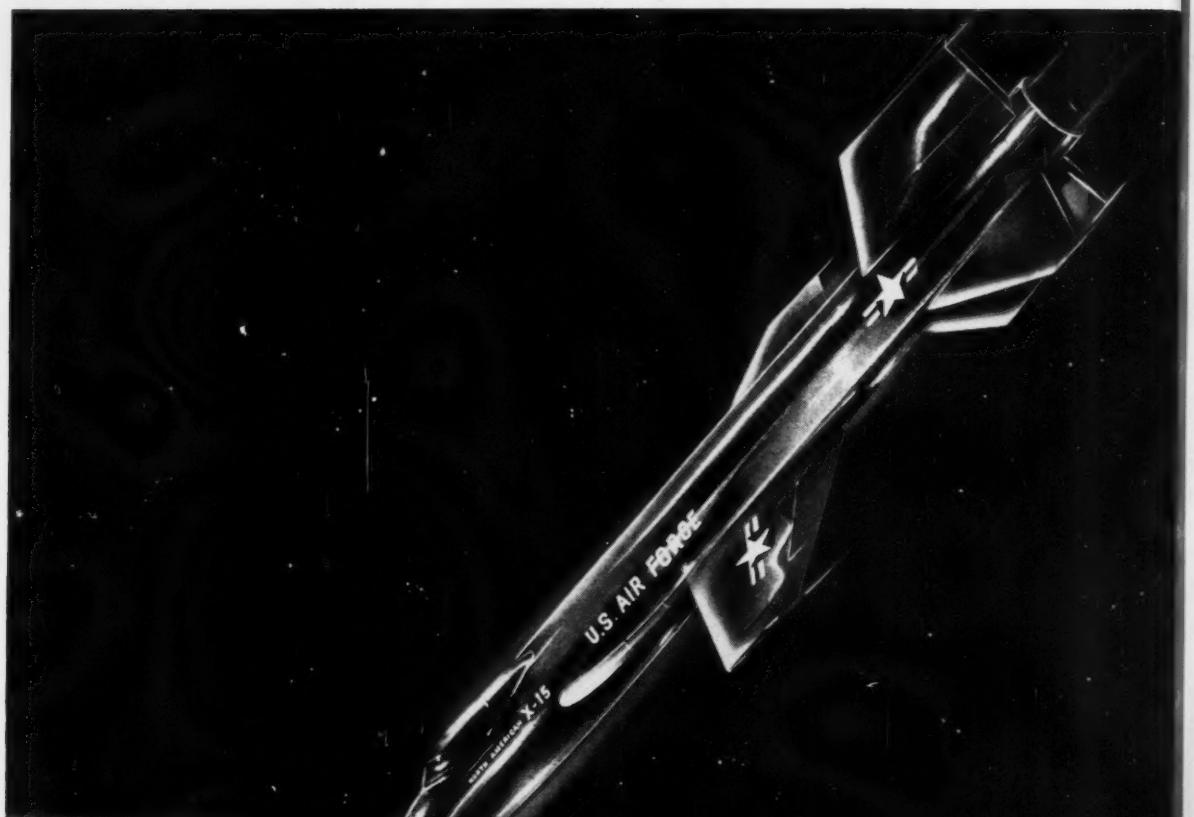

Nosing its way down to earth, X-15's skin of a high-Nickel-containing alloy will glow with the dull cherry red of a tossed rive

Inco-developed alloy to help X-15 carry first man into space

Alloy perfected by Inco's continuing research program will help new rocket plane withstand destructive heats

When the first manned rocket plane streaks in from space, temperatures may build up to as high as twelve hundred degrees.

The ship's nose and leading edges heat to a dull glowing red in seconds. At this destructive temperature, X-15's metal skin could weaken, could peel off.

Aircraft research personnel found the answer to this high-temperature problem in one of a family of heat-treatable nickel-chromium alloys developed by Inco Research. It withstands even higher temperatures than 1200°F!

Remember this dramatic example if you're faced with a metal problem in the future. It may have to do with product design, or the way you make it. In any event, there's a good chance Inco Research may help you solve it with a Nickel-containing alloy.

Over the years, Inco Research has successfully solved a good many metal problems, and has compiled wealth of information to help yo You may be designing a machin that requires a metal that resis corrosion, or wear, or high temper tures. Or one that meets som destructive combination of cond tions. Inco Research can help supp the answer. Help supply the rig metal, or the right technical da from its files.

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Cover by Lowell Hess

In the Next Issue

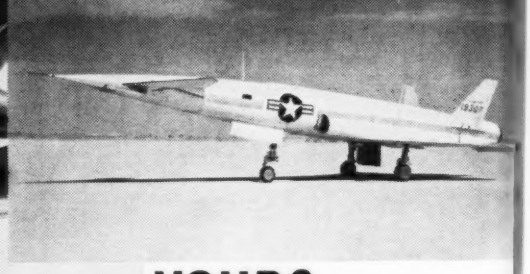
At sea the air becomes hot and sticky. The wind dies. The barometer is high. Suddenly the barometer drops. Lashing rain is pushed forward from the horizon. Hurricane! One hundred mile-an-hour winds revolve around the calm "eye" of the hurricane. How do scientists penetrate the "eye" to predict the path of the hurricane? What causes these giant storms that originate in the Caribbean?

The gibberellins do remarkable things to plants. They hasten flowering, cause dwarf plants to grow to the size of normal plants, cause fruits to develop without pollination, make biennial plants produce flowers in only one season. What are the gibberellins? Who discovered them? How do they work?

Not all the elements occur in nature. Some are man-made. What are their names? How were they discovered? Some have fleeting existences measured in seconds! Why do scientists struggle to solve difficult problems in order to find these elements?

A BRIGHT FUTURE BECOMES REAL WHERE THE AGE OF SPACE IS REAL

Your age is... the Age of Space! And you can build a bright future in this new age by training where the Age of Space is *real*... in the U.S. Air Force. Day to day, Airmen work with supersonic aircraft, rockets, advanced electronics, intercontinental missiles—and soon will work with manned vehicles for outer space. Here is your chance to get a flying start on life. For nowhere else is so broad and complete a range of Space Age specialty training available as in the U.S. Air Force. Get the complete details now. See your local Air Force Recruiter, or mail the coupon below.



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U.S. MAIL Letters

Speed of Sound

Dear Editor:

Why does sound travel faster in warm air than in cold air?

Peter Ihrke
Delaware Township High School
Haddonfield, New Jersey

Answer: The speed of sound depends upon two factors—density of the medium through which it travels (how closely the molecules are packed) and elasticity of the medium (degree of spring or bounce). The speed of sound varies directly as the square root of the elasticity and inversely as the square root of the density of the medium. Therefore, the speed of sound in air changes as the temperature changes.

The speed of sound in air increases two feet per second with each temperature increase of 1.8 degree F.

At living room temperature (68 degrees F.), the speed of sound is 40 feet per second greater than at 32 degrees F. At 32 degrees F. sound travels about 1,090 feet per second in air at sea level, 4,714 feet per second in water, and 16,410 feet per second in steel.

What Makes Earth Turn?

Dear Editor:

Would you please tell me what makes the Earth turn?

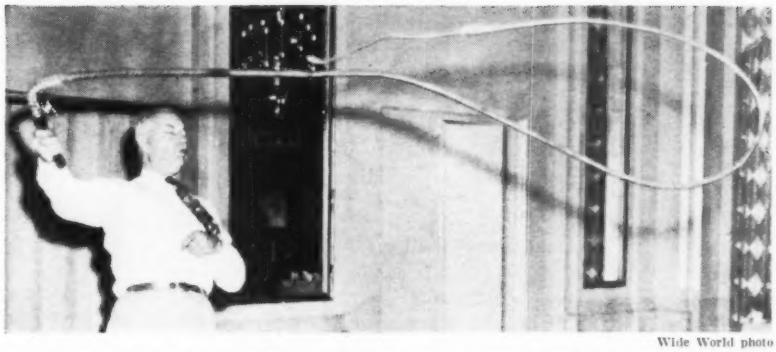
Bernice Marty
St. Louis, Missouri

Answer: The Earth travels through space, but not in a straight line, for it travels around the sun. The force of gravitation exerted by the sun upon the Earth causes it to turn.

No one knows just what gravitation is. Sir Isaac Newton (1642-1727) described it and worked out the laws by which it operates.

There is a gravitational attraction between any two objects in the universe. It acts from the center of one to the center of the other. It tends to pull the objects together.

Are there any questions that puzzle you? Send them to *Science World*. We'll try to answer the most interesting—and occasionally request the answer from you!



Wide World photo

The tip of a bull whip traveling 1,400 feet per second breaks the sound barrier.

The amount of the attraction depends on the mass of the two objects. Mass is the amount of material they have in them. It also depends upon how close together they are.

The Earth has 6,600,000,000,000,000,000,000 tons of material in it. The sun has 333,000 times as much. Therefore Earth is attracted to the center of the sun with a tremendous force.

But the Earth cannot fall straight toward the sun's center because the Earth is moving very rapidly. It travels about 18 and one half miles every second. In the same second it also falls a little toward the center of the sun. The distance the Earth travels and the distance it falls are exactly enough to balance each other. It is enough to keep the Earth turning around the sun in an elliptical orbit.

The Earth turns on its axis a little more rapidly when it is closer to the sun. It turns a little more slowly when it is farther away.

Life Without Oxygen

Dear Editor:

Is it possible for there to be life on planets within our own solar system which are not oxygen breathing organisms?

Leonard Parker
311 North Madison Street
Rome, New York

Answer: On our own planet we have some forms of life which exist where there is no oxygen or only an insufficient supply of it. These organisms do not require oxygen for survival. They are classified as *anerobes*. Anerobes are microorganisms that do not require free oxygen for growth. An example of such an organism is the tetanus bacillus which causes lockjaw.

There may be anerobic organisms on other planets. *Science World* will bring you an article on anerobics in a forthcoming issue.

Why a Whip Cracks

Dear Editor:

What makes a whip crack?

Robert Mamolite
1724-57th Street
Brooklyn 1, New York

Answer: When you snap a bull whip, the whip's speeding tip breaks the "sound barrier." This is the stiff air resistance met by a moving object traveling faster than the speed of sound (see answer to Peter Ihrke's letter).

Navy scientists have shown that the bull whip's tip reaches a top speed of 1,400 feet per second—for about one second. The tip thus cracks the sound barrier. When this happens, a little ball of compressed air piles up just ahead of the speeding tip. An instant later, when the tip slows down, the ball of compressed air "explodes" back to normal. This tiny explosion creates a sound—the whip's crack.

FACTS AND FIGURES

If a man will begin with certainties, he shall end in doubts: but if he will be content to begin with doubts, he shall end in certainties.

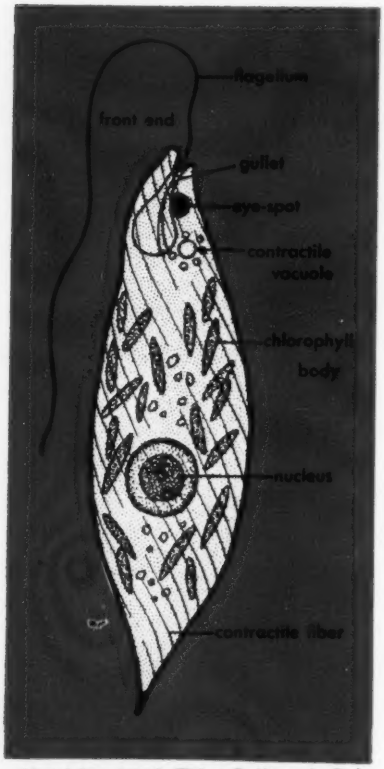
—*Francis Bacon*

At the Edge of Life

. . . are the organisms that are both plant and animal

WHEN is an animal a plant? When it's a Chrysamoeba, of course.

Does this seem like a puzzle to you? It's just as confusing to scientists. You may identify a dog, a cat, or a goldfish as animals. And a rose, a weed, or a tree all are plants. But there are some living organisms that show the characteristics of both plants and animals. How do scientists classify such organisms? What are the characteristics that distinguish an organism as a plant or animal?



Adapted from Animals Without Backbones, by Buchsbaum (U. of Chicago)

Euglena, a green plant-like flagellate, is seemingly an animal, but manufactures its own food supply, as does a plant.

Some of these characteristics are obvious. For example, suppose you place your finger into a fish bowl and stir the water. What happens? The fish seem to notice your presence. They swim away from your finger. The plants in the bowl seem to show no sign of response. You conclude that the fish are aware of your presence and the plants are not.

Experiments have shown that plants cannot move of their own accord. They must stay in one place all the time. Thus plants cannot search for their food. They must manufacture their own food supply. Green plants are able to do this. They contain a green pigment called chlorophyll. In the presence of sunlight, chlorophyll enables carbon dioxide from the air to combine with water from the soil to produce the plant's food. (The plants in the fish bowl are water plants. They get their carbon dioxide from air dissolved in water.) The process by which green plants make their food is called *photosynthesis*.

Animals on the Line

Animals, of course, are unable to carry on the process of photosynthesis. Instead they must search for their food.

What do animals eat? If they do not eat green plants directly, they eat animals that once ate green plants. The food of all animals can be traced back to green plants.

Let's now take a look at some organisms that occupy the transitional zone between plants and animals. One such organism is the sponge in the adult stage.

The adult sponge is attached to the floor beneath a body of water. It is stationary. It does not swim. If it can't move and if it can't manufacture its own food, how does it get its food? This question puzzled scientists for half a century.

Our early scientists classified sponges and all other stationary animals as plants. Modern scientists have discovered that the internal organs of a sponge produce currents in the water. These currents draw food to the sponge. Thus the sponge does not have to move to get its food.

Exceptions such as the sponge make it difficult to tell whether the simple forms of life are plants or animals. Let's have a closer look at these simple forms of life.

Worldly Travelers

From the intense heat and drought of the desert to the cool waters of rivers and oceans to the warm, moist, nutritious interiors of man and other animals—in all these places can be found the most worldly group of all travelers, the Protozoa. These nomads travel by every means of transportation. Carried afloat by ocean currents, whisked from the ground by land breezes, or clinging to the legs of birds or the fur of animals, these microorganisms are distributed throughout the world.

When the forces of nature inhibit the life of some protozoa—as when a pond dries up—they secrete a hard, impenetrable protective shell around their outer surface. Then they become inactive. This shell is called a cyst. The heavy walls of the cyst can resist even the heat of the desert. After a rainfall or after a journey by wind or animal to a favorable en-

vironment, the cyst breaks open. Once again the protozoan assumes an active state. This may last for only an hour or less. Then once more the protozoan becomes encysted. And it may be taken by the wind to habitats far away.

If it were possible to gather a world assembly of protozoa, we would have in attendance representatives from over 15,000 species. They would come from every part of the world and *its inhabitants.*

Biologists are quite certain that many species which they have not yet been able to discover would arrive via air, sea, or land. With such an enormous number of delegates, you would probably imagine that we would need the space of the U. N. General Assembly Hall. Actually all we would need is five small dishes. The biologist has divided protozoa into five classes according to their primary method of movement: the ameboid protozoa, the ciliates, the spore-formers, the suctorians, and the flagellates.

Take Your Choice

At the edge of life are the flagellates. They share some of the characteristics of both plants and animals. These microorganisms get their name from threadlike projections called flagella (singular—*flagellum,* meaning "whip"). The whip-like movements of the flagella propel these tiny organisms.

The trained eye of the biologist identifies in some of the flagellates the presence of chlorophyll, which enables these flagellates to carry on photosynthesis. Should the biologist stimulate the flagellates, a curious thing occurs. They respond to the stimulus.

Surprised? So is the biologist. But he also sees other flagellates which not only carry on photosynthesis but can also feed as animals!

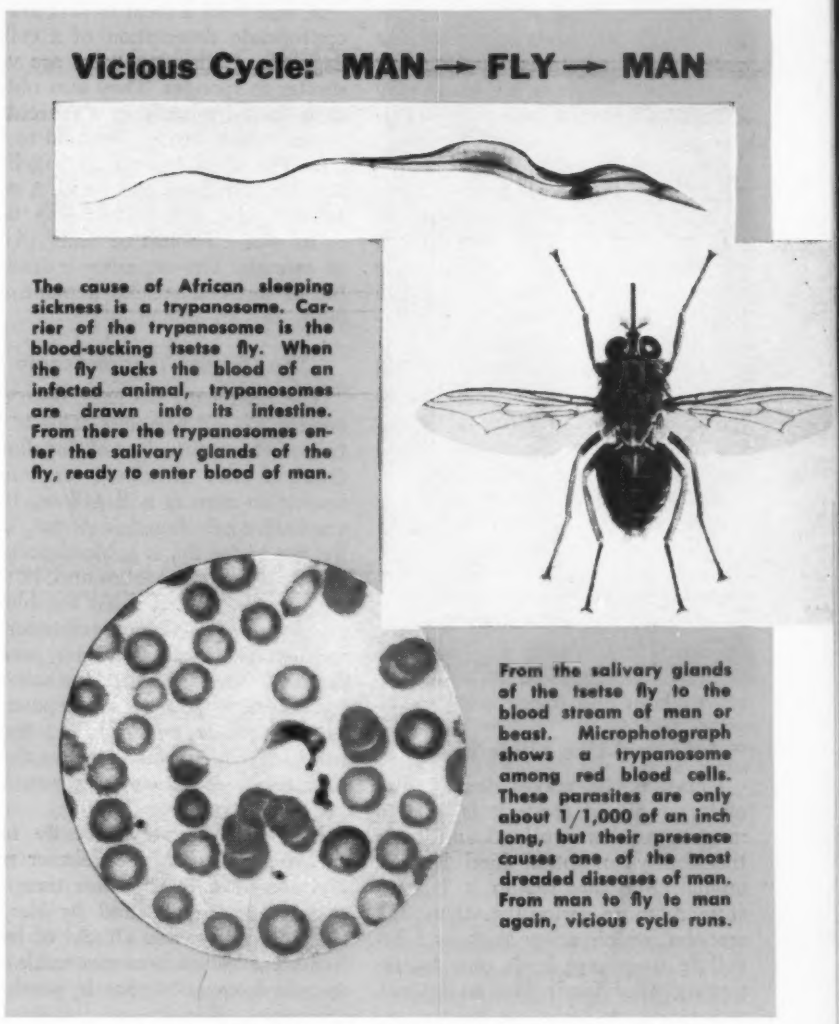
What are these organisms, plants or animals? The problem really becomes confusing when a turn of the fine adjustment wheel of the microscope reveals a third type of flagellate. This type has lost its chlorophyll and takes in solid food particles through a mouth. These *must* be animals. If they are, what are their relatives?

After much study, some zoologists decided to eliminate the difficulties involved in distinguishing primitive plants from primitive animals. They grouped the flagellates and other protozoa into one group together with the bacteria. They named this group *Protista.* Other zoologists separate these groups. They assign all bacteria and all green flagellates to the botanist. Still others include them in the animal world. To this date, scientists have not agreed on a classification for these organisms.

To simplify matters, let us divide the flagellates into two groups: the plant-like flagellates, which make their own food by the process of photosynthesis, and the animal-like flagellates, which have to capture and ingest other organisms. Since the plant-like group is the more primitive one, let's examine it first.

Have you ever noticed green scum on the surface of a pond? Millions of green flagellates called *Euglena* probably make up this matter. If a zoologist were classifying Euglena he would probably put it in the plant kingdom. His reason: Euglena depends upon photosynthesis for its food. To prove his point, he would drop some water containing euglenas on a glass slide and place the slide on the microscope stage. They quickly move to the side of the slide nearest the light. The botanist would agree that as long as they are exposed to light the euglenas carry on photosynthesis.

Let's now ask a botanist to classify Euglena. He would probably say that Euglena is similar to true animals. Euglenas lack a cellulose wall and are very flexible. He would point out that euglenas have a depression at the


Vicious Cycle: MAN → FLY → MAN
The cause of African sleeping sickness is a trypanosome. Carrier of the trypanosome is the blood-sucking tsetse fly. When the fly sucks the blood of an infected animal, trypanosomes are drawn into its intestine. From there the trypanosomes enter the salivary glands of the fly, ready to enter blood of man.
From the salivary glands of the tsetse fly to the blood stream of man or beast. Microphotograph shows a trypanosome among red blood cells. These parasites are only about 1/1,000 of an inch long, but their presence causes one of the most dreaded diseases of man. From man to fly to man again, vicious cycle runs.

Photos from American Museum of Natural History and General Biological Supply House, Chicago

anterior end of the cell. This serves as a mouth and leads into a tubular gullet. But the botanist would admit that these structures are in no way connected with the organism's nutrition.

The organism is able to move by means of a long flagellum which projects from its mouth. The tip of the flagellum rotates. This motion pulls the organism through the water. The ability to move from place to place is another point in favor of classifying Euglena as an animal.

The zoologist and botanist still cannot agree on the kingdom to which Euglena belongs, so let us examine another plant-like flagellate, Chrysamoeba (*see cover*).

Observing Chrysamoeba under the microscope we see a fascinating spectacle occur. Should this oval-shaped body with a yellow-green photosynthetic pigment lose its single flagellum, it will send out pseudopods (false feet), as does the amoeba. In this form it is able to move about and ingest solid foods.

Animal-Like Flagellates

Chrysamoeba makes doubly sure of its supply of food; it is able to manufacture its own food, and it has the ability to obtain food like an animal. For this reason it is considered more primitive than the amoeba, which never assumes a flagellate stage and feeds only by ingesting solid foods like an animal.

A vase with a stem in it is a very appropriate description of a collar-flagellate. Collar-flagellates are very similar to sponges. They also obtain their food by creating a current in water, which carries the food to the cell. The stem is really a flagellum which whips back and forth. A stalk attaches this flagellate to the floor of its water habitat or other plants or animals. The organism is incapable of movement, like a plant, yet feeds like an animal.

The Deadly Trypanosome

The organisms we have been discussing are all harmless. This is not true of the entire class of flagellates. One of the deadliest organisms known to man is a flagellate. It is carried by a fly found in Africa. This fly, the tsetse fly, is a blood-sucking insect. It bites its victim and, in seconds, quenches its thirst for blood. But it leaves a lasting reminder of its visit. As the blood is being sucked from the victim's body, the salivary glands of the tsetse fly are depositing microscopic organisms called *trypanosomes*, which cause African sleeping sickness. These trypanosomes also are flagellates.

The bite of the tsetse fly may not cause illness for weeks or possibly months. During this time the trypanosomes deposited by the fly multiply. When the attacks of fever begin the victim becomes weak and anemic from poisonous by-products given off by the trypanosomes. Finally the organisms invade the fluid surrounding the brain and spinal cord. The victim loses consciousness and death results.

In its early stages sleeping sickness can be cured by drugs. If the parasitic trypanosomes are not quickly killed by the injected drugs, however, they may become drug-resistant. Subsequent injections do not affect them. Should the victim be bitten again, some of the trypanosomes enter the tsetse fly, travel to its intestine, and invade the salivary glands. Once again they are able to enter the blood of man.

In afflicted areas millions of people live in fear of a disease carried by an insect one half inch long.

Let's return from hot Africa to the cool waters of our fish bowl. The living organisms in the fish bowl were easy to identify. The fish are animals and the water plants are plants. But it is not so easy to identify the more primitive forms of life. Scientists examining these organisms at the edge of life must take many factors into consideration.

Plant or Animal?

Let us suppose that one of the primitive flagellates should lose its flagellum. It can no longer move about to get its food. But it stays alive by manufacturing its own food through the process of photosynthesis. In this state the flagellate resembles very simple plants called *algae*.

Other flagellates, which depend upon photosynthesis for their food supply, could survive if they *lost* their chlorophyll. They would then behave exactly like animals.

At the International Oceanographic Congress, which met at the United Nations this month, a British scientist reported that life may have had its origin in the mud of tidal rivers. An American scientist of Yale University was of the opinion that life may have begun at the bottom of ponds or along seacoasts. It is thought that both plant and animal kingdoms arose from primitive flagellates, for these were among the earliest forms of life.

As you can see, some of science's most exciting research is at the edge of life itself.

—SIDNEY SELTZER

British Information Service photo

This trained microscopist is studying a blood smear in sandbank laboratory near the Zambesi River Valley in Africa.

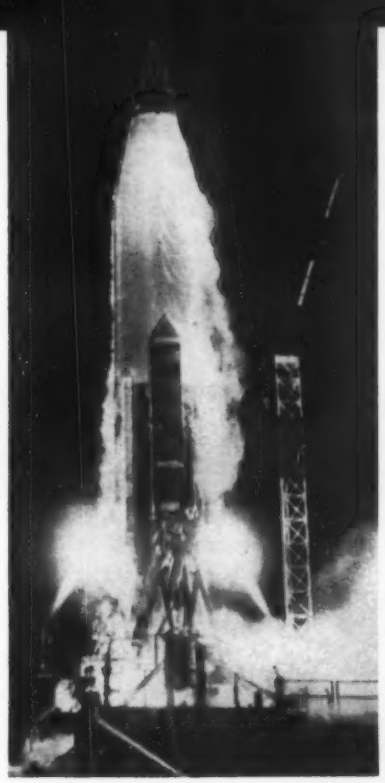
British Information Service photo

This member of the Kenya Veterinary Department is using a portable sprayer in the campaign to wipe out tsetse flies.

By ISAAC ASIMOV

New Uses for Old Elements

The elements, fundamental building blocks of the universe, don't change . . . but chemists find new and ingenious ways of juggling these blocks



Wide World photo

Oxygen, used in rocket fuel, makes up 46 per cent of Earth's crust, 89 per cent of weight of clouds and water.

OXYGEN has a glamorous new use that produces thunder on Cape Canaveral and lightning in the air above it. But there is nothing new about oxygen itself.

Every man who ever lived has had to breathe air in order to stay alive. And air contains oxygen.

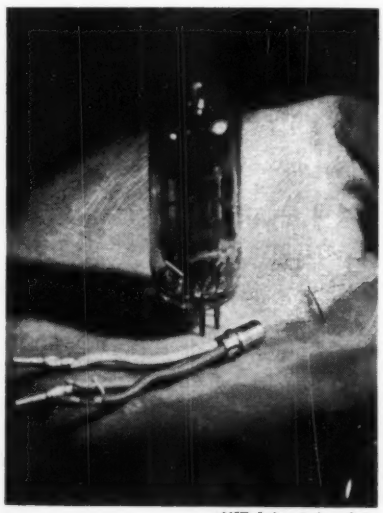
Oxygen was first separated from the other gases in the air in 1772 by a Swedish chemist named Karl Scheele, and two years later by an English chemist named Joseph Priestley. In the century and a half since then, scientists learned that pure oxygen had many uses.

Doctors administered it to patients who had trouble breathing, by giving them a kind of "concentrated air." Torches were devised that mixed oxygen with acetylene gas. The flame was hot enough to cut steel as though it were butter.

These uses did not require much oxygen. Other than for natural uses, the world got along with small quantities.

Suddenly, after World War II, the annual production of pure oxygen doubled, doubled again, and still again. A new and highly dramatic use was consuming it by the ton—as a liquid!

Pure oxygen gas, cooled to a temperature of −183 degrees C., exists as a super-frigid blue liquid. Thousands of gallons of this liquid oxygen are required to launch one rocket. The liquid oxygen enables the rocket fuel to burn rapidly. This produces the power that places satellites into orbit.



MIT Laboratories photo

Germanium transistor, and tiny cryotron *(right)* made of niobium and tantalum do job of vacuum tube in radio equipment.

From Eyewash to Rockets

Yet oxygen is a very common substance, the most common on Earth, and without doubt the most important. The gas is colorless, odorless, and tasteless. It occurs chiefly in water and metallic oxides which form the Earth's crust, and makes up one fifth of the air we breathe. About two thirds of your body is oxygen—in compounds.

Far less common than oxygen is a hard, black solid material called boron. This element was first discovered in 1808. Boron is not found free in nature. It occurs as a compound in certain volcanic spring waters and minerals.

Minor uses developed for boron. Combined with other substances, it formed boric acid and borax. Boric acid is a mild antiseptic that you may have used as eyewash. Borax can be dissolved in water to make richer suds when soap is added. Apparently, boron was fated to remain in the medicine cabinet and the laundry. No glamor there.

But let us come back to the rockets. Boron, when combined with the gas hydrogen, forms what are called boron hydrides. These boron hydrides, added to rocket fuel, cause it to release extra energy when it burns with oxygen.

Suddenly the laundry chemical is a source of booster power for the tremendous "birds" at Cape Canaveral. And out of the eyewash we have intensified the thunder of the rocket motors.

Oxygen and boron are examples of elements, the fundamental building blocks of the universe. Each element is made up of a special kind of atom. Atoms have different weights, but they are constant for each element. So far scientists know of only 102 different kinds of atoms. They know, therefore, only 102 different kinds of elements. Everything in the universe is made up of these elements and of their combinations.

The first scientific list of elements was prepared by the French chemist Antoine Lavoisier in 1789. He included 23 known elements in his list. He also included several compounds of elements, in the mistaken belief that they were elements. Later the "mistake" was corrected by other scientists, for with better instruments to weigh and measure things came increased accuracy.

In 1869 the Russian chemist Dmitri Mendeleeff discovered that elements show similarities when they are arranged in groups according to their atomic weight. Mendeleeff painstakingly arranged the elements in order of *increasing* atomic weight. The table of elements we use today is based on his periodic law.

Westinghouse photo

This bar of niobium is being made ultrapure at temperature near 4,400° F. inside coil carrying high frequency current.

When science develops a new need that requires a substance with special properties, it can't turn to anything "brand new." It must go back to the same old elements, and find some new way of using them—by themselves or in combination.

And they *are* "old" elements in terms of the history of modern science. Oxygen and boron were first prepared over one hundred and fifty years ago. By that time, fully 45 of the different elements were known. In the next hundred years, 40 more elements were discovered. Only 17 elements have been known for less than fifty years, and these "new elements" are all extremely rare. Most, in fact, have been prepared only in the laboratory. With one exception, which we will discuss later, the "new elements" have not been put to practical use so far.

Uranium—Cinderella Story

The most dramatic Cinderella story among the elements is that of *uranium*. It was first discovered by a German chemist named Martin H. Klaproth in 1789. He named it for the planet Uranus, which had been discovered a few years earlier. For 100 years, uranium remained on a few laboratory shelves.

Then, in 1896, the French chemist Henri Becquerel discovered uranium was radioactive. He found that its atoms were constantly breaking down into particles and giving off energy. However, uranium still remained of interest only to theoretical scientists probing the structure of the atom. It was used in industry chiefly to give a canary yellow color to fluorescent glass.

But in 1939 it was discovered that uranium atoms could be "fissioned"—they could be split in such a way that each atom, as it broke down, brought about the destruction of a neighbor. In this way a "chain reaction" was built up, so that in a millionth of a second an incredibly destructive explosion could result. Such an explosion was produced for the first time in July 1945 at Alamagordo, New Mexico. The "atomic bomb" had been born.

But uranium fission can be used not only for destruction but for the peaceful production of power as well.

Power plants using the splitting uranium atom now drive submarines and supply a few communities with electricity. In time to come, they will power ocean liners and possibly airplanes and spaceships.

Uranium is now one of the most valuable metals on earth. Prospectors search deserts and jungles for new sources of uranium.

An even greater possible source of power involves the gaseous element *hydrogen*. This was first isolated by the English chemist Henry Cavendish in 1766.

Hydrogen is the lightest substance known. Since it is lighter than air, about 50 years after its discovery it was used to fill balloons. Thus it enabled men to explore the higher reaches of the atmosphere. It was also used as a fuel, for it burned energetically in oxygen.

However, in the last 15 years or so we have found that hydrogen can be used as a fuel in a new and catastrophic way. Not just the atoms themselves, but their central cores (the atomic nuclei) can combine (or "fuse") to form new atoms. In this way, hydrogen atoms will combine to form helium. The energy released by this union is even greater than that released by splitting uranium atoms. Hydrogen bombs are even more destructive than ordinary atomic bombs.

But scientists all over the world are trying to tame the hydrogen fusion reaction, to cause it to run steadily without an explosion. If this can be done, the world will have a greater source of power than it has ever known before. This is a glamorous prospect for the lightest element we know, which stands in first place on the periodic table.

From Sand to Solar Battery

Consider *silicon*. Next to oxygen it is the most common element we know. It makes up about one fourth of the crust of the earth. It was discovered in 1823 by the Swedish chemist Jons J. Berzelius. For more than a century, silicon had no uses at all as an element. In fact, hardly anyone (including chemists) had ever seen pure silicon.

To be sure, in combination with other elements, silicon formed useful substances, such as quartz, sand, granite, clay, glass and ceramics. For

silicon itself, however, there was no task to perform.

Now silicon is used in "solar batteries" to turn the energy of the sun into electricity. These batteries can produce energy forever, or as long as the sun shines—in theory, at least.

There is a tiny solar battery in the six-inch sphere that is the Vanguard I satellite. It is because of this solar battery that we have been getting continuous radio signals from Vanguard I for nearly two years now, making it the most useful of the satellites, though the smallest. The instruments in Explorer VI, one of our newest satellites, are powered by thousands of solar cells. Perhaps large solar batteries spread out over desert areas where the sun nearly always shines will some day power whole cities. In fact, like hydrogen, silicon may be a major power source of the future.

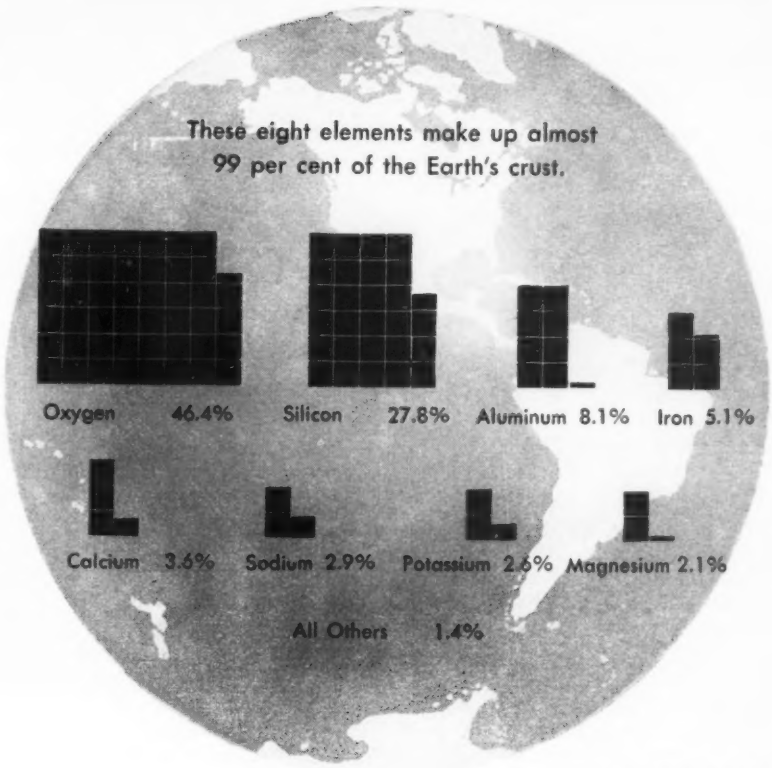
Wire for Man-Made "Brains"

An element closely related to silicon (but much rarer) is *germanium*. It was discovered in 1886 by a German chemist named Clemens A. Winkler.

In 1869, 17 years before germanium was discovered, Mendeleeff had predicted the existence of the element. He said it would be gray-white in color and have an atomic weight of 72. Winkler found the element in a silver ore. After testing the element carefully, he announced that Mendeleeff's prophecy had been fulfilled. He named the new element germanium in honor of his fatherland.

Again, germanium was without uses at first—just something for chemists to play with. A little over a decade ago, however, it was found that germanium crystals had a special property. They could be made to carry a current one way, but not the other. The crystals did the same job that ordinary "vacuum tubes" did. But they took up far less space and were more rugged. In 1948 the "transistor" made its appearance. This small device employing germanium was able to do the job of the vacuum tube. (Transistors can also be made of silicon.)

Using transistors instead of ordinary tubes, it becomes possible to "miniaturize" electronic equipment. A satellite the size of a basketball can circle the Earth and send down a great variety of new information.



Science World graphic

In Earth's crust and in oceans and atmosphere are found 94 of 102 known elements. The other 8 elements are man-made, and are believed to be non-existent in nature.

A new device even tinier and simpler than the transistor is the "cryotron." It is composed of two wires of different metals twisted together—nothing more. You can place the cryotron on the palm of your hand and hardly know it is there.

If these wires are cooled to a temperature close to absolute zero (—459 degrees F.), one of them becomes "superconductive." That is, it will carry an electric current without offering any resistance. This current will then flow or not flow, depending upon whether current is also flowing in the other wire. The device becomes an "on-off switch."

Cryotrons can be placed in computers, with the result that a small computer can have space for more switches (and can therefore perform more operations) than a large computer depending on ordinary electronic equipment. Perhaps in the future small desk computers will do what now is done by a whole wall of intricate wiring and tubes.

What composes the wires that make up the cryotron? The elements *tantalum* and *niobium*. These are similar metals discovered at about the same time. The English chemist Charles Hatchett discovered niobium in 1801. He found it in an ore sent to England from the New World more than a century earlier by John Winthrop, first governor of Connecticut, and called it "columbium." The Swedish chemist Anders G. Ekeberg discovered tantalum in 1802.

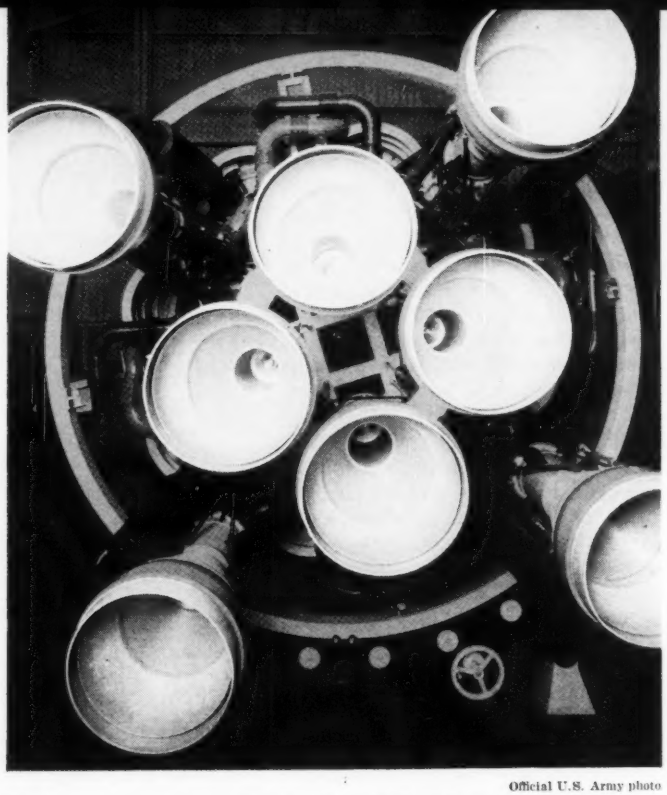
In the past, these elements have been used in electric light filaments, in pen points, in certain dental and surgical tools. Niobium was added to stainless steel to make it more resistant to corrosion. But who could have guessed at the future awaiting these elements in the vitals of "thinking machines"?

The story continues. Other elements have been glamorized out of a drab past into a glorious present. Still greater glories undoubtedly lie in wait for the future. There are only a few score elements, perhaps, but their uses can never be exhausted, for human ingenuity is inexhaustible.

SCIENCE WORLD
Takes You There

PROJECT SATURN

A visit to Redstone Arsenal with
WILLY LEY



Official U.S. Army photo

This is a quarter-size mock-up (scale model) of Saturn's engine cluster. Outer engines will be shed after rocket takes off, then fished from sea.

REDSTONE Arsenal, near Huntsville, Alabama, has been a busy and growing place for the last eight years. But now, as I can testify from a recent visit, it is busier than ever. And most of the busy-ness centers on Project Saturn.

For example, you are shown through the enormous hall where Jupiter rockets are constructed for testing. You admire a machine that automatically will make an electric weld around the 105-inch diameter body of a Jupiter rocket. The machine will not only make the weld, but also take X-ray pictures of the weld at intervals of one inch, so that inspectors can see whether the weld is unflawed. Beyond this machine there is just a lot of empty floor space. Why? This floor space has been cleared for Project Saturn.

Or else you may enter the building with the two wind tunnels. Both are supersonic wind tunnels (one was originally built in Germany), and some work is going on in one of them. The other is ready for a run, and you can watch. The run concerns the air flow around the tail end of Project Saturn.

Or you are shown around the so-called component test stand. This is a building where parts of a large rocket may be tested. For example, scientists and engineers may want to find out how a switching assembly behaves when in a vacuum. Or else they may fire a small rocket motor designed to have a vital function as part of an assembly.

Incidentally, at this component test stand they have done something very ingenious, mainly because it is so simple. You may have to watch the firing of a rocket motor very closely. Elsewhere I have seen this done by means of closed-circuit television or by a periscope arrangement. At Redstone Arsenal they simply have a small Army tank ready. It can drive the observer right up to the test cell. If the rocket motor should blow up—well, tanks are designed to protect their crews.

At any event, one of the test cells holds a miniature version of the propulsion end of Project Saturn.

In another building a mock-up (full scale model) of Project Saturn is being assembled. The main test stand, which can hold and test a complete Jupiter missile on either side, is being modified. When the work crew is finished the test stand will still be able to test a Jupiter missile on one side. The other side will have been modified for Project Saturn.

After all this, the answer to the question "What is Project Saturn?" is overdue. But several different answers, each one truthful, are possible. So the subject is best approached in a roundabout way.

The rocket motor of the first large liquid fuel rocket, the German V-2 used during World War II, developed a thrust of 60,000 pounds. The take-off weight of the rocket was about 28,300 pounds. For a long time no larger rocket motor was built. The first rocket motor that was larger—non-Russian, that is—was that for the Redstone missile. The Jupiter missile needed a still heavier rocket motor. And a recently improved version of the Jupiter's rocket motor has a take-off thrust about three times greater than that of the V-2 rocket motor.

Cluster of Eight Engines

Project Saturn consists of putting eight of these improved rocket motors together to produce a take-off thrust of 1½ million pounds. This is enough to make the completed

Saturn booster into a vehicle that will carry as its second stage the first stage of the Titan missile.

In short, the Saturn booster can put almost anything into an orbit around the Earth. It can carry a payload to the moon which would have sounded like sheer fantasy only last year.

Quite a number of innovations are involved in this. In the first place, every one of the eight rocket engines looks different. (A "rocket motor" is the device in which the fuel which produces the exhaust blast is burned. A rocket engine is the motor plus the fuel distribution system, the fuel pumps, the turbine which drives the fuel pumps, etc.) Usually the fuel pumps and the turbine are located on top of the rocket motor. In Project Saturn they are attached "side saddle," as it is called at Redstone Arsenal, so that the engine is shorter.

New Type Starting Fuel

Then there is the attempt to avoid misfiring, by having the rocket motors start with a "hypergolic combination." Normally the motor of a large rocket must be ignited mechanically when the fuel is alcohol or RP-1 (a kerosene-type fuel), and the oxidizer is liquid oxygen. But there are some combinations, such as aniline and nitric acid, that will burst into flame spontaneously when the two liquids come into contact with each other. These spontaneously igniting fuel-oxidizer combinations are so called "hypergols." The non-hypergolic combinations are preferred, partly because they are more powerful, partly because there is less chance of accidental ignition.

However, for Project Saturn it is planned to start the rocket motors hypergolically and then switch over to the more conventional fuels. This has been carried out on test stands in static tests with single motors, so we know it can be done.

One other feature, which for understandable reasons is never discussed by anybody in detail, will be a safety device. This, somehow, switches off all the engines if one of them fails to work.

While the eight rocket engines which comprise the propulsion system for Project Saturn are all alike, they are not used in the same manner. The arrangement of the engines is in two groups of four each. Four engines form the inner group, occupying the positions of the four corners of a square. The other four engines form a larger square around the inner square. These four outer engines are mounted rigidly. Their job will simply be to push, with a total thrust of 750,000 pounds.

To Recover Four Engines

The four inner engines are mounted on gimbals, individually, so that they can turn slightly. Their job, therefore, will be not only to push but also to steer. One can steer a large rocket very well by moving the rocket engine a bit. The principle is precisely the same as that used in any outboard motor boat. You steer by deflecting the whole outboard motor.

Now it may be more efficient to obtain a longer burning time by using only four of the eight engines. At take-off all eight of them are needed, of course. But after a certain velocity has been reached, you might do better if you use only four engines and have them burn for a longer time. But if you use only four of the eight, there is no reason why the other four should still be carried along. The most practical way of getting rid of some of the rocket engines is to make a part of the tail section detachable.

This has been carried out successfully with the Atlas missile. The Atlas uses three rocket engines at take-off, and after a while sheds the two outer ones. In Project Saturn, the four outer engines would be left behind. They would be shed as a ring-shaped unit.

Because this unit would be quite expensive, it is planned to try parachute recovery for the whole unit. Thus it can be fished from the ocean, reconditioned, and used again.

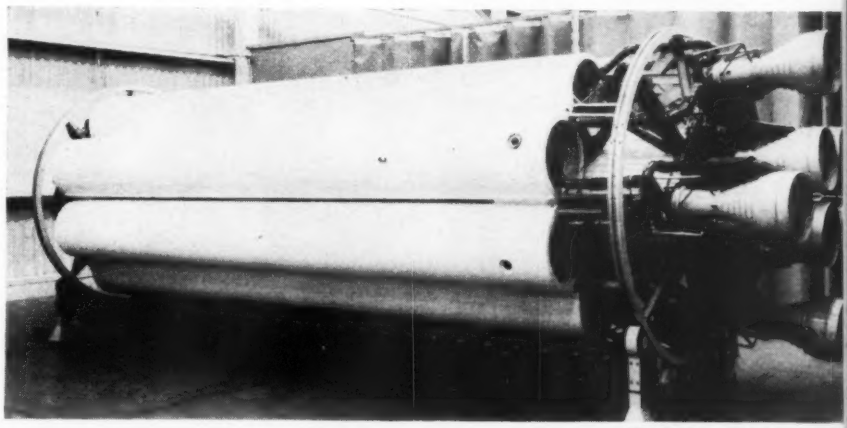
So far parachute recovery has been successful only with parts of large rockets, such as cameras and instrument capsules. The largest rocket to be recovered as a whole is, to my knowledge, the Aerobee rocket. But in the case of Saturn it will pay to try for recovery of the four fixed engines and everything that goes with them.

To Be Test Fired This Fall

It is expected that the Saturn will be test fired on the ground this fall. If everything goes well, the first actual firings from Cape Canaveral can be expected in 1960. A single "package" with an "earth weight" of 20,000 pounds will be sent into orbit around the earth.

In the meantime, in California, another project is going on. While the men at Redstone are making a cluster of eight rocket engines for a 1½ million pound take-off thrust, the men in California are developing a single rocket engine with the same thrust. They are likely to be finished with their engine development at about the time Saturn goes into orbit. Then we'll have a single rocket engine with the same thrust.

And then we'll cluster that one!



Official U.S. Army photo

Saturn booster will be 75 ft. tall, 22 ft. in diameter, have 1½ million lb. thrust. Clustering is new technique of massing existing rocket engines for higher thrust.

Science in the news

Mountains in Motion

Campers in Montana's Madison Canyon, just west of Yellowstone National Park, crawled into their sleeping bags one evening last month. The rushing babble of the Madison River lullabied them to sleep.

Suddenly the ground shuddered convulsively. "Earthquake" someone yelled.

Young Phil Bennett, 16, looked up from his sleeping bag. He saw the top of a 7,200-foot-high mountain "cascading down on us." Fifty million tons of dirt and granite—jarred loose by the tremor—slammed into the canyon.

Next morning a rescue party found Phil and his mother sitting among the boulders. Phil's two sisters, his brother, and his father were dead.

The landslide killed at least six other campers. Hundreds were trapped in isolated areas. Roads were buried under 200 to 350 feet of rubble.

The earthquake had "remodeled" Madison Canyon as easily as a bulldozer pushes around a pile of feathers. The giant landslide sealed the canyon from wall to wall for three quarters of a mile. The Madison River formed a new lake behind this natural "dam."

Also a casualty was the Hebgen Dam, seven miles upriver. The earthquake tilted the lake behind the dam as simply as a diner tilts a bowl of soup. The dam and the shoreline were lowered three feet, plunging a half-mile chunk of highway into the lake. At the same time, the opposite shore of the lake was raised three feet.

The lake water was tilted away from the dam and then slammed back at it. A wall of water—25 feet high—rushed over the dam. The impact ripped open a crack 25 feet long in the top of the dam. But the dam held.

How Quakes Are Triggered

The Montana earthquake released energy equal to 10,000,000,000 pounds of TNT or 2,500 Hiroshima-sized atom bombs. Yet the shock waves which accompany adjustments in the Earth's crust have rocked the Earth even more.

How do earthquakes happen? Not all originate in the same way. But most result from the great natural forces that are constantly building mountains, forming oceans, and reshaping the contours of land and sea. These forces have been at work for millions of years. The 6,000 years of our recorded history are only a very short period in geological time.

The Earth's crust consists of huge blocks or slabs of rock piled on top of each other. These slabs are constantly being pushed and pulled by tremendous pressures. Over millions of years most of the slabs have settled down. A few are still "sensitive." They need only one "last straw" of pressure to make them crack or slip.

This "last straw" could be many things. It might be shrinkage of the Earth's crust, a volcanic explosion, or even the shock waves from another quake thousands of miles away.

G. A. Eiby, noted Australian seismologist and author of *About Earthquakes*, states that earthquakes may be regarded as "an effort of the Earth to return to normal after it has been slowly strained over a long period of time."

Suppose the area in figure "A" of the diagram on page 15 represents a large tract of land, perhaps 50 to 100 miles wide. Suppose that the weakest slabs of rock in the tract lie along the dotted line in figure "B." If the Earth is strained by forces building mountains, or by movement between large sections of the crust, it will slowly become deformed. Pressure will be placed on the weakest slabs. The pressure may become very great, as when a spring is tightly coiled. When a sudden break occurs, energy will be released, as if the coiled spring were suddenly let go. The rocks along the line of weakness—called a "fault"—move to take up a new, unstrained position, as in "C."

"The movement is greatest near the line, and gets less and less as we go away from it," writes Dr. Eiby. "It is the waves set up by this sudden movement which we call an earthquake."

Wide World photo

Earthquakes occur along a "fault" or line of weakness, as in photo of Montana quake *(above)*. Scientists say quake is not a sudden abnormal happening, but an effort of Earth to return to normal after being strained for a long period of time.

UPI photo

Water in lake behind Hebgen Dam in Montana was tilted. Pressure of water surging back opened crack in dam.

The process of fracture and displacement of the Earth is known to the geologist as "faulting." Faults may be millions of years old. Not all movements along geological faults are rapid enough to cause earthquakes.

Geologists estimate that the Earth is rocked by as many as 20,000 earthquakes annually. Each shock is usually followed by an after-shock of smaller magnitude. Why? Suppose you jump onto a bed. You'll bounce up—and then you'll bounce down and up and down again several times. Similarly, an earthquake touches off answering shocks.

The Montana earthquake, for example, was followed by six strong aftershocks, and about 365 smaller tremors.

Geologists all over the world picked up the Montana shock on their seismographs. These instruments measure shock waves resulting from earthquakes. There are three types of shock waves: the primary wave (P wave), the secondary wave (S wave), and the long wave (L wave).

The P wave, the fastest, is propagated through the Earth at five miles per second. The S wave is a little slower: three miles per second. The L wave is transmitted at two miles per second. The L wave, however, does most of the damage.

How Quakes Are Pinpointed

Earthquakes are pinpointed by comparing the time lag between the arrival of the P wave and the arrival of the S wave. If the time lag is eight minutes, for example, the seismologist knows the quake occurred 4,000 miles away.

The seismologist will chart this information on a map. He will draw a circle with a compass. The radius will be 4,000 miles. The center of the circle, of course, is the seismograph station. Other seismologists all over the world will do the same thing. Then they will compare circles. The circles will intersect at one point and pinpoint the earthquake.

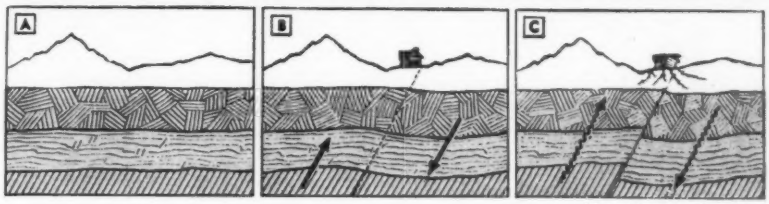
One of the largest recorded earthquakes occurred in 1950 in the area where Tibet, India, and Burma border each other. The crusted block that is Mount Everest gained nearly 200 feet during this adjustment.

Sometimes an earthquake may occur beneath the ocean floor. Then a huge wall of water—falsely called a "tidal wave"—rushes in all directions. In 1765 such a wave smashed into Lisbon, Portugal, killing 10,000 people.

The world's worst known earthquake occurred in China in 1920—killing 200,000.

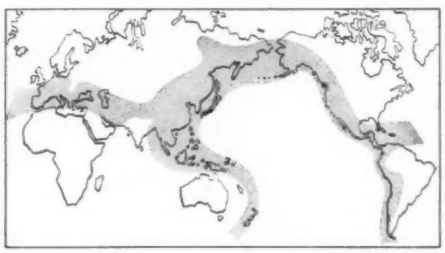
Luckily, the U. S. is shaken by only 700 quakes annually. Most are mild.

How Earthquakes Happen and Are Recorded



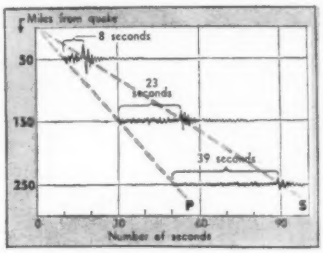
Adapted form New York Times

Earthquakes are caused by sudden movement of rocks within crust. Crust consists of slabs of rock piled on each other (A). Powerful stresses (B) constantly strain slabs, which may eventually snap along a line of weakness (C). Movement shakes ground.



Adapted form New York Times

Mountain-building goes on slowly in geologically "young" areas. This is where earthquakes occur. Montana quake was on edge of such area.



Adapted from About Earthquakes by Elby (Harper)

Waves P and S travel at different speeds. Farther seismograph from quake, longer lag from P to S.

Eclipse Oct. 2

One of the world's most spectacular heavenly displays, a total eclipse of the sun, will occur at sunrise on October 2, in the eastern United States.

Only those lucky enough to live in or travel to a narrow belt of eastern Massachusetts that includes Boston or southern New Hampshire will be able to see the total phase, weather permitting. Millions in the eastern U. S., however, will be able to view a partial eclipse, if clouds do not interfere.

The sun will be wholly covered by the moon for watchers in a narrow strip extending from Massachusetts across the Atlantic Ocean to the Canary Islands, then through the Sahara Desert, the Sudan and Ethiopia, ending in the Indian Ocean. The eclipse occurs at 5:50 a.m. E. S. T. in the Boston area.

Outside this ribbon, observers will see the sun partially eclipsed over a vast area reaching from Greenland to the southern part of Africa, and from Michigan to Moscow.

Atmospheric conditions will be extremely favorable at the Canary Islands, a Spanish possession near the coast of northwest Africa. Youngest astronomer there will be Tim Wyngaard, 17, of Madison, Wis. (*see pp. 20-21*).

A total solar eclipse occurs when the moon comes between the sun and the Earth, blotting out the sun's light for a brief time for those in a narrow path on the Earth's surface.

Soviets Hit Moon

Soviet scientists scored a bull's-eye on on the moon with the first man-made space vehicle to be sent from one cosmic body to another—a sphere weighing 858.4 pounds. It crashed into the moon at a speed of about 7,500 miles an hour, making the 236,875-mile journey in about 35 hours. It landed at two minutes and 24 seconds after midnight (Moscow time) September 14—two days before Premier Nikita Khrushchev's scheduled arrival in the United States.

The sealed sphere carried two radio transmitters (each broadcasting on two frequencies), a Soviet pennant and hammer and sickle emblem, batteries, and scientific instruments.

The instruments were designed to gather information on the magnetic field of the Earth and the moon, the belts of radiation around the Earth, the intensity and variation of cosmic rays, the heavy nuclei of cosmic rays, the density of matter in space, the gas components of interplanetary substance, and on the number of meteoric particles encountered. The last stage of the rocket also carried a radio transmitter that broadcast on two frequencies.

The sphere was carried to the moon by a multi-stage rocket. One hour after launching, after the final stage had escaped from the Earth's gravitational pull with a speed exceeding seven miles a second, the sphere and final stage were

(Continued on next page)

Science in the news

separated. They entered the gravitational field of the moon at a speed of 1.44 miles a second. As they approached the moon, it exerted an increasing pull and their speed was 2.06 miles a second at the moment of impact.

Both the final stage rocket and the instrument sphere traveled at slightly different speeds and in slightly different trajectories toward the moon. As we went to press, it was not known whether the rocket and the sphere struck the moon at the same point or at the same instant.

The space vehicle rammed the surface of the moon at a point among three large depressions in the moon's surface. As we went to press, it was not known whether the rocket shattered on impact or penetrated the dust that is believed to blanket much of the moon's surface. All radio signals ceased at the moment of impact.

Soviet scientists say they took special pre-launching measures to prevent the sphere from contaminating the moon with microorganisms from the Earth.

The final stage of the rocket was tracked by radio signals and direct observations. For about one minute during its course the final stage emitted a bright yellow cloud of sodium vapor. The cloud was photographed by two Soviet observatories using special light filters. It was believed the course of the rocket could be corrected from the ground if it strayed from its path.

The moon shot required delicate guidance instruments. Although the moon is 2,160 miles in diameter, hitting the moon poses special problems. It is equivalent to firing from a moving and rotating platform (the Earth) at a target that is also moving and rotating. The velocity of the moon in orbit is 2,287 miles per hour.

Science World will bring you a complete report on the Soviet moon shot in the next issue.

Salt Water Irrigation

Double the agriculture potential of the earth with one single stroke—that is what salty water can do.

The equivalent of a whole new continent could be added to the world, in the opinion of Dr. Hugo Boyko of Israel. For many years, Dr. Boyko told fellow scientists attending the International Botanical Congress recently, an experimental garden has been flourishing in the desert in Israel. It is watered only with brackish water from a salty spring. The soil is 61 per cent granite and limestone pebbles and rocks, with about 23 per cent coarse sand.

No fertilizer is applied, the Israeli researcher said, yet pomegranates, mulberry trees, sycamores, and olive trees are thriving. Altogether, there are some 180 species of trees, shrubs, and other plants. These were selected for their resistance to drought and usually originated in arid and semi-arid Mediterranean regions.

Dr. Boyko explained that these plants were living proof that desert soil and salt water can support an agriculture.

Farmers usually associate salt or sea water with crop destruction. Sandy or gravelly soil is usually thought of as not being farm land. The two "evils"—salt water and so-called bad soil—can be combined to add millions of acres to agriculture.

There is a good reason for this: salt water percolates through the coarse soil. Thus the plant's roots do not stand in the salty water. The plant has all the benefit of the salt water without any of the harmful effects.

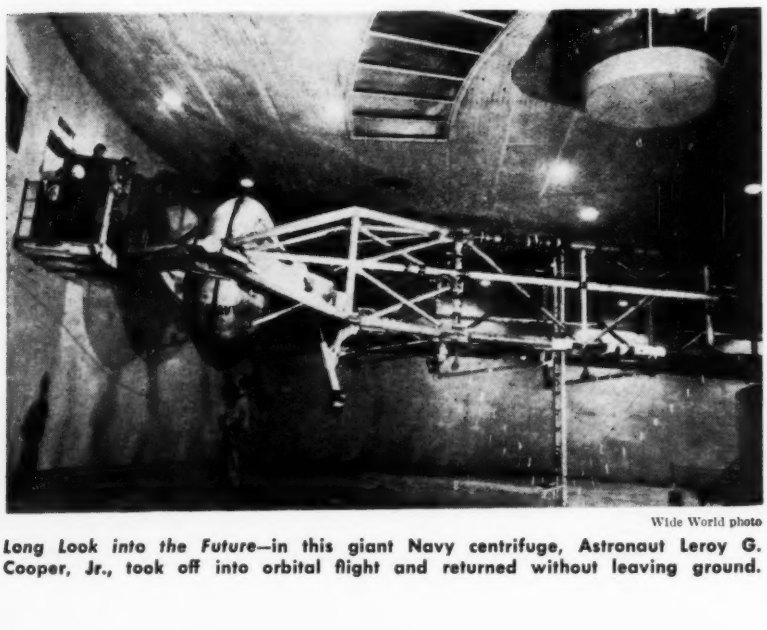
Plants in the experimental garden were irrigated with water salty enough to make a person sick if he were to drink the water.

The only species that failed to survive were those with short root systems. The other plants were able to go three weeks, during an unusual drought, without irrigation. Actually, Dr. Boyko explained, the plants needed less water than "you would suppose." Once a week was enough. Plants could also be irrigated with fresh water, following the salt water, without harm.

The salt does not accumulate since it passes down through the coarse soil. When it reaches bed rock the salt is carried out to the sea.

Shifting sand dunes can also support a crop. Barley, sugar beets, wheat, grass and Israeli esparto grass—used in paper making—can all be grown, Dr. Boyko said. Water with a salt content higher than the Sahara's underground resources of brackish water was used for irrigation.

With Dr. Boyko's method of salt water irrigation, it may be possible to make the arid and semi-arid lands of the world more productive.



Wide World photo

***Long Look into the Future*—in this giant Navy centrifuge, Astronaut Leroy G. Cooper, Jr., took off into orbital flight and returned without leaving ground.**

Wide World photo

Taking a fast spin is Astronaut Malcolm S. Carpenter, riding in giant centrifuge.

Hay Fever–One Shot

Relief for hay fever sufferers may be just one shot away.

Recently about two dozen hay fever patients in Chicago received a one-shot inoculation to immunize them against ragweed pollen.

Current relief from hay fever consists of a series of injections. These build up immunity to the hay fever allergen and reduce the severity of such symptoms as sneezing, running nose, red eyes, and itchiness. These injections desensitize the victim to hay fever. The injections are made of pollen extracts. The treatment consists of injecting very small doses which are gradually increased in size. This is done before the hay fever season, during it, or all year round. It is both time consuming and expensive.

The body reacts to the injections by counteracting them with antibodies. More antibodies are produced than are needed. Thus the patient has a reserve of these immune substances to use in fighting future attacks.

Dr. Mary Loveless, an immunologist at Cornell University, developed the one-shot inoculation. Her method consists of putting ragweed extract in an emulsion of mineral oil and injecting one large dose.

It is believed that the extract is gradually absorbed from the injection site over a long period of time. Thus it lasts through the hay fever season.

The one-shot inoculation will be a boon to hay fever sufferers. At present they visit their doctor for 15 to 30 shots over a long period of time.

Current Kills Cancer

Electricity can successfully kill cancer without harming normal tissue.

Two research scientists at Johns Hopkins University reported that they successfully used an electrical current to kill cancerous tumors in mice without harming the animals. This is what they did:

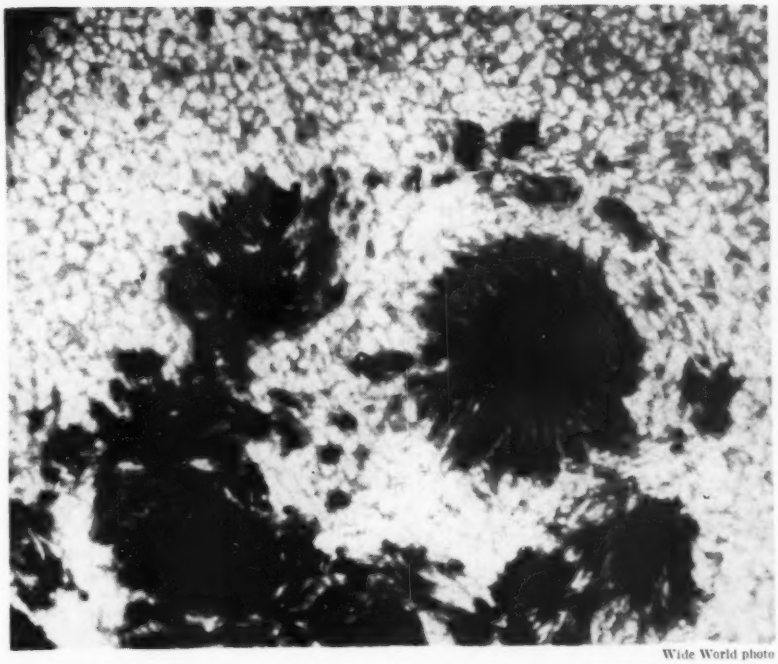
Tissue of tumor sarcoma 180 was injected between the shoulder blades of Swiss albino mice. Tumors quickly began to grow at these points of injection in the mice.

Then a plastic saddle was fastened to each mouse. The saddles contained a copper electrode covered with sponge rubber that had been soaked in a solution of water and table salt.

Each "saddled" mouse rested upon a rod covered by copper and sponge rubber. Electricity flowed from the saddle, through the tumor, to the rod upon which the mouse was fastened. The current was controlled to prevent burning the skin tissue. Each mouse was treated for an hour and then allowed to rest for an hour.

Control mice also received tumor cells between their shoulder blades and wore the saddles and equipment, but they did not receive any electrical current. Within 21 days, all the control mice died.

The mice receiving the electrical current, however, were in good shape after 21 days. More than 60 per cent of the tumors of these mice had shrunken and dropped off, leaving a new skin surface where the tumor had originally grown. The remaining animals died later, probably from the effects of the tumors still growing.



Wide World photo

Sharpest sunspot photo made shows dark core of cool gases surrounded by wispy filaments of outward moving warmer gases. Spots interfered with radio on earth.

Wide World photo

Dr. Martin Schwarzschild *(above)* made photo at top of page. Balloon bore telescopic camera up 80,000 feet, where air was free of dust and water vapor.

Serum from Plants

Plants given human red blood cells have reacted to the injection "like people." They produced serum containing antibodies.

This is the first reported reaction of a plant to a human antigen (substance which stimulates the production of antibodies).

A Yugoslav medical researcher, Aleksander Mitrovic, reported that he was successfully obtaining serum artificially from living plants. The serum is to be sent for testing and study to scientists in Europe and America.

Red blood cells of blood group "O" were injected into the trunks of ten plants. Some plants died, others lost their leaves. After one month, sap from the living plants was extracted. Seven and one-half liters—a little more than seven and one-half quarts—of serum were obtained.

Hundreds of samples of human blood were then tested with the serum. The plant extract "behaves in the same way as reagent obtained from humans," the Yugoslav scientist reported.

A practical application of this research might be its use to identify human blood types.

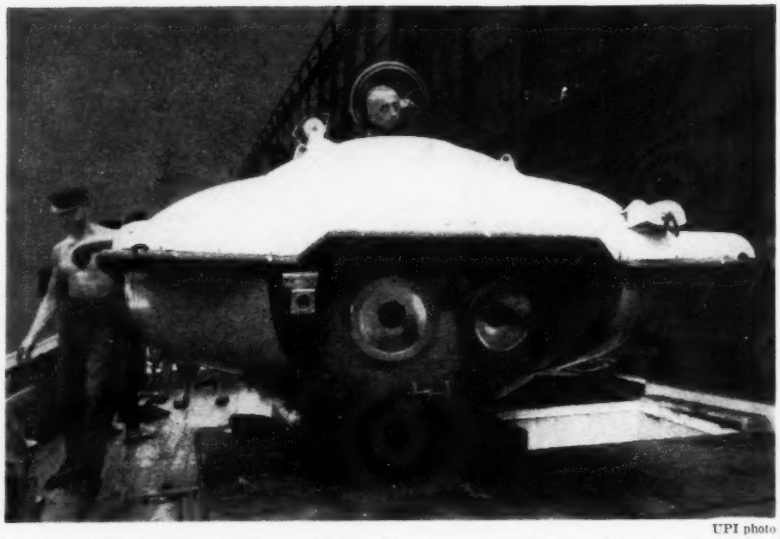
Oceanographers

Oceanographers, who study the seas and oceans and their phenomena, gathered at the United Nations in New York from August 31 to September 12.

There they held the first International Oceanographic Congress. Scientists exchanged information and ideas on the most recent developments in the study of oceans.

The Congress was arranged by the American Association for the Advancement of Science. Co-sponsors were the United Nations Educational, Scientific, and Cultural Organization (UNESCO) and the Special Committee on Oceanic Research of the International Council of Scientific Unions.

Science World will bring you a complete report on the meeting next issue.



UPI photo

Seven oceanographic vessels, used to explore seas, were displayed in New York Harbor during meeting of oceanographers at United Nations. On deck of *Calypso* from France was diving saucer *(above)*. Saucer can dive a quarter mile. Scientists take photos from windows. Saucer moves by squirting water from nozzles in rim.

Cars Without Wheels

Up, up, and away! It's a bird, it's a plane, it's a super-car!

The horseless carriage may one day be replaced by the wheel-less carriage. In November a four-passenger "Air-Car," manufactured by the Curtiss-Wright Corp., will appear on the auto market. It can swoosh along on a cushion of air at a top speed of 60 miles per hour.

What keeps the Air-Car up? Its 300 horsepower motor spins a large fan. The fan blasts air downward, lifting the vehicle 6 to 12 inches off the ground. The Air-Car can travel over land, water, marsh, snow, or ice. Only drawback: the surface below must be very flat.

The wheel-less carriage could lighten the load on hard-pressed American taxpayers. How? Roadbuilding programs could be slashed. New roads would simply have to be leveled out. No pavement would be needed. Nor would bridges be required. An Air-Car can slip right over a river or stream.

The Air-Car is just right for people with a parking problem. It moves sideways—as well as backwards and forwards. And it can rotate—just like a merry-go-round. How do you brake an Air-Car to a stop? Simple: Just point the exhaust pipe in the direction you're heading. You'll glide to a stop.

Other companies are experimenting with air scooters. Saunders-Roe, a British aircraft company, tested its "Hovercraft" this summer. It skimmed across the English Channel to France—a distance of 23 miles—at an average speed of about 11 miles per hour.

The Ford Motor Company also sees flying cars in its future. It recently displayed a full scale model of its Levacar "Mach I." The Levacar would spear along—a fraction of an inch off the ground—at a top speed of 500 miles per hour. Three powerful air jets would boost the car up. Another jet would propel it forward.

As automobiles catch up with the airplane, one important question remains to be answered. The question: Should the owner of a wheel-less car apply for a driver's license or for a pilot's license?

Golden Waters

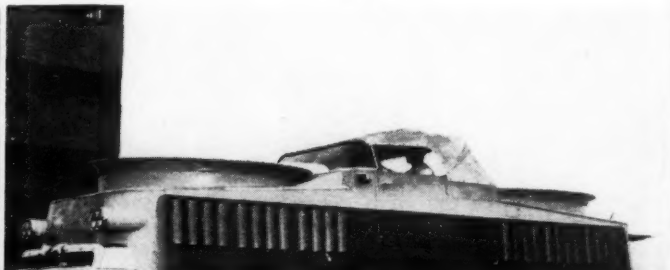
Reversing the California gold rush of 1849, the Army Corps of Engineers is putting gold back into San Francisco's Golden Gate Harbor.

This time the gold is radioactive. Gold 198, the material used, gives off radiation for a little less than three days. By letting the gold mix with the harbor sediment, engineers will be able to trace the movement of the sediment with Geiger counters.

Dredging costs $2,000,000 a year. By using the gold to trace the sediment in its travels, engineers hope to reduce dredging costs.

Ford Motor Company

Look, it "slides on air." Wheel-less Ford Levacar uses air propulsion, new concept in high speed, long distance travel.



Wide World photo

Another car that really takes off—6 to 12 inches off ground, that is! No wheels or clutch for Curtiss-Wright air-car.

Curiosity Catchers

Have some pranksters played a mean trick on "The Thinker"?

Was it lightning that did this? How would you prove it?

WHAT does it take to arouse your curiosity? Does it take a magician pulling rabbits from a place you didn't expect them to be? Or appearing to saw his pretty assistant in half? Would you be curious about an automobile with five wheels, or a cat with two tails, or a girl with green hair?

Can the commonplace also excite your curiosity? Don't forget the fictional apple falling on Isaac Newton's head, or Edward Jenner's noticing that milkmaids, especially those who milked cows afflicted with cowpox, didn't catch smallpox. To notice the thing that is only slightly strange can sometimes trigger a chain of events that lead to an invention or a discovery of very great importance.

The things that catch your curiosity may not lead you to cures for cancer, new ways to synthesize sugar, new explanations for radioactivity, or other equally important discoveries. But you will find that a well exercised curiosity can add more interest to the whole business of living.

To give you some of the fun of exercising your curiosity, *Science World* includes in each issue some Curiosity Catchers, things we hope will arouse your curiosity and spark it into planning experiments and investigations with the other members of your class.

For the science class that sends in the best plan of attack for following up each Curiosity Catcher, *Science World* will award a science reference book for the classroom shelf—a book of your choice!

Each class entry must be postmarked not later than 30 days after the date of the issue in which the Curiosity Catcher appeared. Address your entry to Curiosity Catchers, Science World, 33 West 42nd Street, New York 36, N. Y. Entries will be judged on how clearly the problem is worded, on how much additional information has been brought together, on the probable fruitfulness of hypotheses, and on the strategy with which experiments or investigations are planned or carried out.

Project and Club News

Countdown for Science Youth Month

OCTOBER is National Science Youth Month. Actually, every month is Science Youth Month, but activities really start to roll in October. During this month, you can do your share by joining a science club. If your school or community does not have one, join with other interested students to organize one.

Start planning for local, state, and national science fairs. Encourage the organization of a fair if your school does not have one.

Plan "how-to-do-it" sessions to share ideas and techniques in exhibiting science fair projects.

Enter the projects in the Student Achievement Awards program of the Future Scientists of America Foundation, and in the National Science Fair.

Register with your science teacher for the Science Talent Search examination (if you are a senior), and keep working on your research project. The project report is due in December!

Plan a "career" meeting for your club. Consider asking a scientist or panel of scientists to discuss careers in science.

Feature science this month in other clubs to which you may belong.

Get your science activities program rolling today! Thirty-four national groups have joined with Science Service to aid you and your club prepare for a big science activities year. Parents, teachers, businessmen, scientists, engineers, and other interested citizens are behind you 100 per cent.

During Science Youth Month take action for a year of adventure and excitement in the world of science.

Astronomy Award

Tim Wyngaard, 17, a senior at West High School, Madison, Wisconsin, has won a trip to the Canary Islands with a scientific expedition. He was sponsored by the National Academy of Sciences IGY Committee as a junior member of a team of scientists who will travel to the islands to study the total eclipse of the sun on October 2.

"In giving this recognition to Wyngaard for his astronomical activities," said Dr. Detlev W. Bronk, president of the National Academy of Sciences, "the Academy and its IGY Committee hope to inspire other young people to consider careers in science."

Tim was nominated by the Astronomical League at the request of the IGY Committee. His interest in astronomy dates from the sixth grade. A teacher noticed Tim's interest in astronomy and asked her son to take Tim to a meeting of the Madison Astronomical Society. Two years later Tim helped organize the Junior Astronomical Club at Madison, serving as its first president.

Tim's first telescope was purchased with money earned after school. Now he has the use of the 15.6-inch telescope at the Washburn Observatory of the University of Wisconsin. With it he has made a special study of the moon's Picard Crater, which has unusual banded markings.

The young astronomer will spend approximately one month at the eclipse site, off the coast of Africa. He will work as a member of a joint expedition from Sacramento Peak Observatory, Sunspot, New Mexico, and High Altitude Observatory, Boulder, Colorado.

This expedition is one of four groups which will observe the eclipse, as part of the follow-up to the International Geophysical Year—International Geophysical Cooperation—1959. The expedition will make a second attempt at experiments that were frustrated by cloud cover last October in the Danger Islands of the Pacific. As a participant in that venture, the National Academy of Sciences sponsored David Morrison, amateur astronomer who has just graduated from Danville (Illinois) High School.

The location for this year's observation site was selected in part because it offered the best chance for clear weather. It is at the southern tip of Fuertaventura in the Canary Islands. The Spanish Government has offered full cooperation.

Wide World photo

It took David Milne, 17, two and half years to build electronic Braille typewriter. He built the device from parts he found in scrap yards and Army and Navy surplus stores. An ancient portable typewriter, Dave's self-designed and built "brain," and electrobrailler he manufactured by adapting its punch system to an electric drive, make up project. Effort won Dave a $1,000 scholarship.

USNC-IGY photo

Tim Wyngaard's work in astronomy won him spot on expedition bound for Canary Islands *(see map below)* to study eclipse of sun October 2.

The SacPeak-HAO group, of which Tim will be a member, hopes to observe a spectacular but very brief eclipse phenomenon known as the flash spectrum. More than two years were spent preparing the equipment for observing this event, which lasts a maximum of about 50 seconds.

The flash spectrum occurs both at the beginning and end of eclipse totality. Parts of the sun's lower atmosphere, which ordinarily look dark against the bright background of the sun's disk, suddenly appear to flash out when the background is blocked off by the moon.

Professors Paul Kellogg and Edward Ney of the University of Minnesota, working in French Africa, will test another theory. This theory suggests that the solar corona (the outer edge of the sun's atmosphere) consists of trapped charged particles similar to the Van Allen radiation belts ringing the Earth (*see page 22*).

Findings will be significant not only in terms of basic research, but in future attempts to send instrumented rockets to the vicinity of the sun.

Tim is very active in his school science group and is in line for its presidency this year. With all his extra-curricular activities and his after school job, he still keeps up a B plus average.

An interest in science has proved rewarding for Tim. It can be for you, too.

School Fair Winner

An exhibit designed to explain the basic principles of paper chromatography won first prize in chemistry at the Altoona (Pa.) High School Science Fair. This project was the work of John William Dreese, 16.

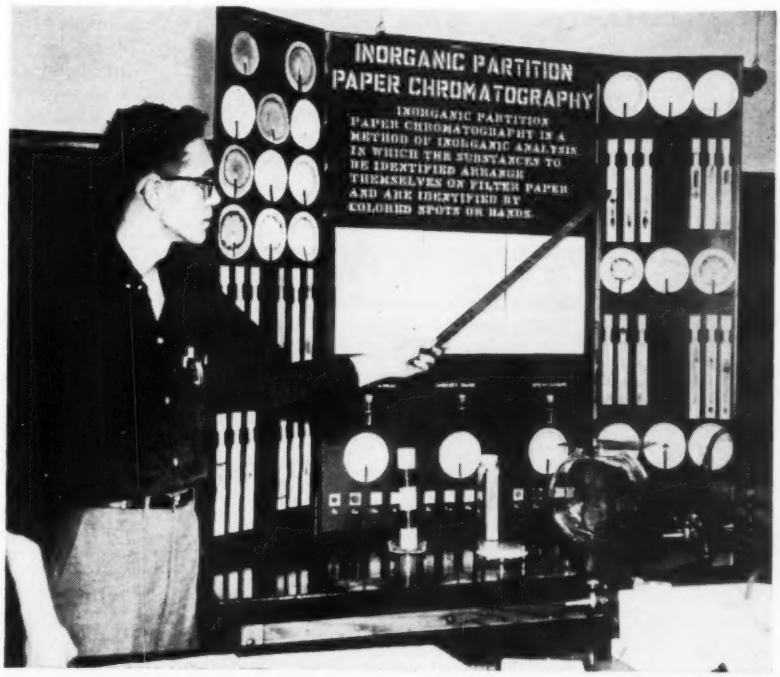
Paper chomatography is based on the principle that a moving liquid will carry materials up a strip of filter paper through capillary action when an end of the strip is immersed in a solvent. Different materials will be carried different distances. By this method, minute quantities can be separated for either qualitative or quantitative analysis.

John described his exhibit as "inorganic partition paper chromatography." He explained it as "a method of inorganic analysis in which the substances to be identified arrange themselves on filter paper and are identified by colored spots or bands." The exhibit was later set up at the Pennsylvania State Science Fair, held at Pennsylvania State University, University Park, Pa.

When he is graduated in 1960, John plans to attend Pennsylvania State University, where he expects to major in chemistry.

Wanted: News, News, News

Have any members of your school science club or regional science organization carried out especially noteworthy projects recently, or achieved regional or national honors? Write up the news and send it to Project and Club News, Science World, 33 West 42nd Street, New York 36, N. Y. Keep the report as concise as you can, and include photos if clear sharp prints are available.

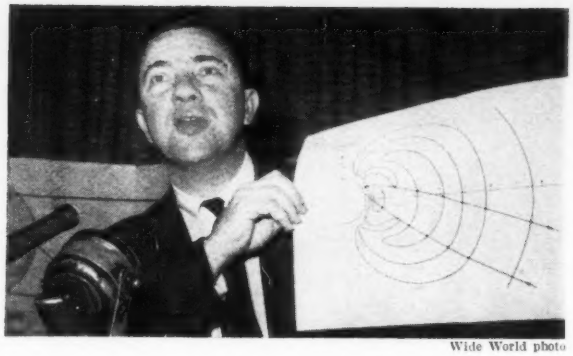

INORGANIC PARTITION
PAPER CHROMATOGRAPHY
INORGANIC PARTITION PAPER CHROMATOGRAPHY IS A METHOD OF INORGANIC ANALYSIS IN WHICH THE SUBSTANCES TO BE IDENTIFIED ARRANGE THEMSELVES ON FILTER PAPER AND ARE IDENTIFIED BY COLORED SPOTS OR BANDS.

Altoona Mirror photo

John Dreese, 16, won first prize in chemistry at the Altoona (Pa.) High School Science Fair with exhibit explaining basic principles of paper chromatography.

today's scientists

JAMES VAN ALLEN . . . Space Detective



Wide World photo

IN THE race into space between the United States and the Soviet Union, the Russians can claim more powerful rockets and heavier satellites. But U. S. scientists have a long lead in scientific achievement.

The man responsible for the U. S. lead is Dr. James Van Allen of the State University of Iowa. The instruments he designed and constructed led to the discovery that there are two belts of cosmic radiation high above the Earth. The radiation belts carry Dr. Van Allen's name, in honor of the part he played in their discovery.

Little was known about cosmic radiation until our own century. Scientists believed that the radiation entered the Earth's atmosphere from outer space, hence called it "cosmic radiation." In 1926 they found that the radiation was absorbed by the air. In 1927 they learned a little more—that there is less cosmic radiation near the Equator than near the poles.

The next year scientists learned still more. Using Geiger counters they found that much of the observed cosmic radiation was really particles that had an electrical charge.

Little by little, as the instruments of science became more precise, we learned more about cosmic radiation. Last year Dr. Van Allen was responsible for the biggest discovery to date—the region of radiation surrounding our Earth.

Under Dr. Van Allen's direction at the State University of Iowa, the basic design of many of the instruments in our satellites was worked out. The quiet, energetic, 44 year-old physics professor has been head of the Physics Department there since 1950.

From The Ground Up

Van Allen was born in 1914 at Mount Pleasant, Iowa, and attended Mount Pleasant Senior High School. He became a crack student. His high school physics teacher said recently: "We just about had to push him out of school at night and lock the door."

Van Allen went on to college at Iowa Wesleyan, a small college in his home town. There he had the good fortune to work with a first-class physicist, Dr. Thomas Poulter. Van Allen was encouraged in his eager attempts to track meteors, survey Mt. Pleasant for magnetism, and measure cosmic rays—at ground level. When Dr. Poulter prepared to sail for Antarctica as second in command of the Byrd expedition, he asked Van Allen to prepare the instruments.

Van Allen did post-graduate work in nuclear physics at the State University of Iowa, receiving his doctorate in 1939. He joined the Carnegie Institute in Washington, and was soon working on war projects.

In the Navy Bureau of Ordnance he served on a team that developed the proximity fuse. This device detonates when it passes near a target.

While working in the laboratory, he met Abigail Fithian Halsey II. She was a mathematician and Navy WAVE. They were married in 1945.

After the war, Van Allen returned to studying cosmic rays. In 1946 he became supervisor of high altitude research at the Applied Physics Laboratory of Johns Hopkins University.

Van Allen and a few other scientists were offered the privilege of designing instruments for the noses of about 100 captured German V-2 rockets. It was planned to fire them from White Sands Proving Ground, New Mexico.

Cosmic rays had been measured as high as 80,000 feet by balloon-borne instruments. The V2s carried measuring instruments up 100 miles. Van Allen, indirectly, became an authority on rocket instrumentation.

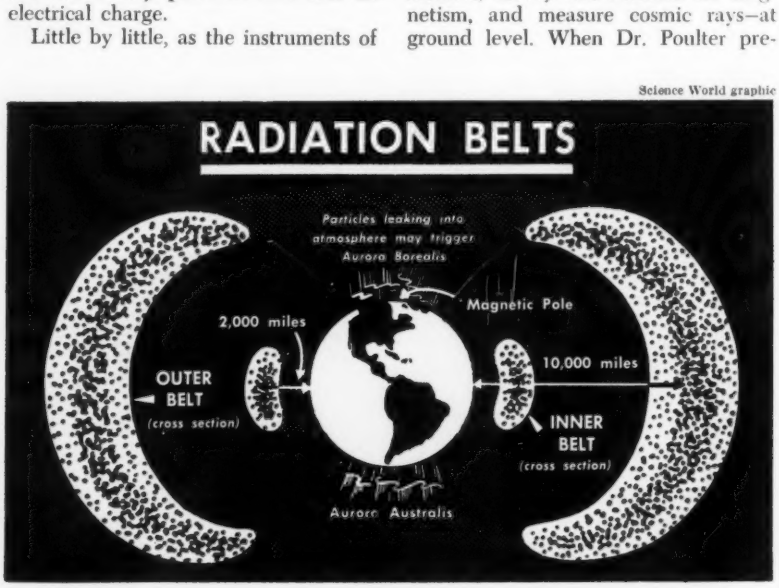
When the supply of captured German rockets ran out, Van Allen proposed and drew specifications for a cheaper rocket—the Aerobee. He designed tiny instruments for the nose of the Aerobee to send back data on cosmic radiation.

In 1950, the Applied Physics Laboratory asked Van Allen to undertake something it considered more practical than cosmic rays—a better proximity fuse. He declined the request and accepted a job as head of the Physics Department of the State University of Iowa.

Back in Iowa, Van Allen built a balloon-rocket combination that could carry an eight-pound payload of instruments 75 miles aloft. Cost: $750. He

(Continued on page 29)

Science World graphic



tomorrow's scientists

Project: Radioactivity in Milk

Student:
Robert Schooley
Anacostia High School
Washington, D.C.
Science Achievement Award Winner

Teacher:
Elaine Kilbourne

[Is the milk you drink radioactive? Here's how a newspaper article led Robert Schooley of Anacostia High School, Washington, D. C., to do a science project on "Radioactivity in Washington, D. C., Milk."]

IN THE Washington *Post and Times Herald* of January 5, 1959, I noticed an article reporting that the Public Health Service of the U. S. Department of Health, Education, and Welfare was measuring radioactivity in milk in only ten cities. The ten cities were Atlanta, Georgia; Austin, Texas; Chicago, Illinois; Cincinnati, Ohio; Fargo, North Dakota; New York City; Sacramento, California; Salt Lake City, Utah; Spokane, Washington; and St. Louis, Missouri. Thus, I learned that there was no systematic attempt to determine the amount of radioactivity in milk from the vicinity of Washington, D. C. It was reported specifically in the March 1, 1959, Washington *Post and Times Herald* that "The milk in Washington, D. C., is not being checked by either the Public Health Service or the Atomic Energy Commission." By coincidence, I was doing such a project.

My science project covers the preparation and measurement of weekly samples of milk purchased in Washington, D. C., for a nine-month period from May, 1958, through January, 1959. The milk was actually produced about 45 miles northwest of Washington.

I found that radioactivity was of a very low level. It was necessary to concentrate the radioactivity by a two-stage boiling and burning process. I also needed to build an electronic counter.

Most radioactive substances found in milk have a relatively long half-life. These are decay products from atomic bomb tests that fall on food consumed by cows. Because of this, quantity varies considerably with time and location. My project compares the radioactivity of Washington-area milk with milk from the ten cities mentioned previously for the month of September, 1958, and also shows the level of radioactivity for each month from May, 1958, through January, 1959.

There are several substances responsible for the radioactivity. These include:

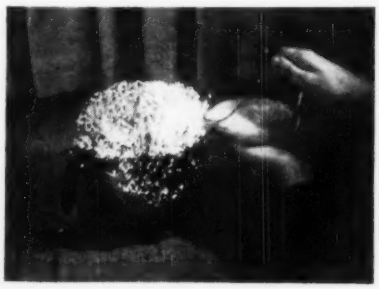
Substance	Half-life	Recognized Maximum Safe Radioactivity (micro-microcuries per liter)
Iodine-131	8 days	3,000
Barium-140	13 days	200,000
Cesium-137	33 years	150,000
Strontium-89	53 days	7,000
Strontium-90	20 years	80

At the present time Strontium-90 is of most concern. It has a long half-life and tends to take the place of calcium in the bone formation in children. Most of the radio isotopes found in milk are Iodine-131, Strontium-89 and 90, Cesium-137, and Barium-140. My measurements include the sum of all the radioactive elements in the milk.

PREPARATION OF SAMPLES

The first step was to use skim milk. This not only rids the sample of troublesome fat that does not contain these isotopes but also reduces the cost of the raw material. The total cost of the skim milk used in this project was about $1.75.

The second step was the removal of water and other volatile matter. This is perhaps the greatest reduction of useless material, for milk is approximately 90 per cent water. This was accomplished by employing the family popcorn popper. Two layers of aluminum foil were placed around the inside to facilitate easy removal. Not more than one quart of milk was placed in the popper and allowed to boil and char outdoors for about 4 hours. This must be done outdoors because the odor in the latter stages is extremely penetrating. Upon completion there would be a charred, solid residue left along



Water was removed in popcorn popper.

Most carbon was burned out of milk.

Samples were prepared in milk caps.

sides and bottom of the aluminum foil.

Unfortunately, there was still not enough concentration of the radioactive material for accurate readings high enough above the background level of radiation. It was encouraging, however, for some radioactivity in the sample could be detected.

My next step was to burn as much of the carbon out of the sample as possible. First, the charred material from the corn popper was ground into a powder using a mortar and pestle. The apparatus shown in the illustration (on page 23) gave me the high temperature (red hot) needed for the next phase of sample preparation. It consists of two 1,000-watt cone elements of the type used in household radiant heaters. A porcelain crucible containing the ground material was placed inside the upright cone. The cone on the left in the illustration has a larger diameter. This allows it to fit over the top of the one on the right. There are also three holes around the side of the upper one (when in place for burning), so that air can circulate up through the crack between the two elements and out. This supplies oxygen to the sample, allowing it to burn.

The material above and below the cones consists of pieces of asbestos shingles. It is used for shielding to protect the electrical cords from the intense heat generated. After the electricity was turned on, the sample burned violently for about 15 minutes, depositing a large amount of carbon on the upper asbestos plate. The heat was left on for another 20 minutes to insure complete and uniform burning of all samples.

Next the sample was ground again to a fine powder using a smaller mortar and pestle. The final phase was to get a uniform amount to expose to the Geiger tube, for varying amounts in different samples would give unreliable readings. I found that aluminum milk caps were excellent for holding this powder, and our milkman was consulted. He very generously supplied me, free of charge, the new caps necessary for this project. New caps are particularly desirable because they have a flat lip that assures uniformity of filling. Part of the ground sample was packed as tightly as possible. The excess on the top was planed off with a straight-edged tool, giving a smooth, level surface. There was also the need for something to hold the powdery sample in the cap so that it could be handled and stored without spilling. A mixture of 1/3 model airplane clear dope and 2/3 dope thinner proved excellent for this task. When applied with an eye dropper it hardened, making the sample quite permanent. After drying, the milk cap was labeled on the bottom, and the sample was ready for readings.

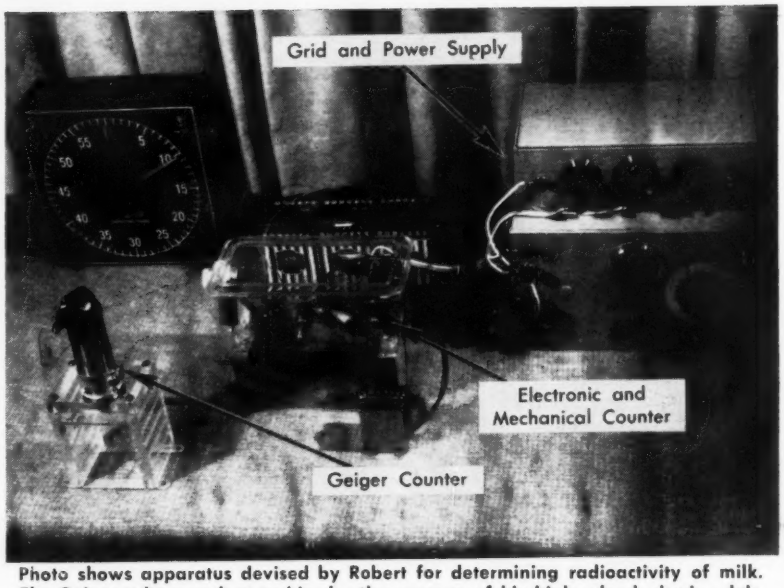


Photo shows apparatus devised by Robert for determining radioactivity of milk. The Geiger tube was lent to him by the sponsor of his high school physics club.

This process proved very efficient for concentrating the samples of milk. Just how much concentration was attained is interesting. My local pharmacist, who was interested in my project, allowed me the use of his chemical balance. Starting out with a quart of skim milk, I found that the weight was about 975 grams. The weight of the residue of this quart after being boiled and charred in the popcorn popper was 55 grams—a loss of 920 grams or about 94 per cent, principally water. It was not possible to fit the 55 grams into my crucible for the burning process, so I weighed out 19 grams. After the burning was completed, it weighed 8.5 grams. Thus

$$(8.5)\ \frac{55}{19} = 24.6 \text{ grams}$$

which would have been the weight if the whole one-quart sample could have been burned. The original weight of 975 grams is about 40 times this number.

In this manner samples were prepared each week from May 10, 1958, through January 24, 1959. This gives a total of 38 samples covering a period of nine months.

DESCRIPTION OF APPARATUS

General

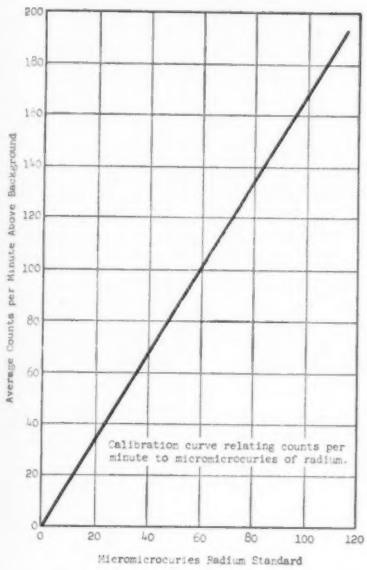
The illustration above shows the complete apparatus set up. The objects on the far right are power supplies. On top is the grid supply, encased in a cigar box. It supplies negative voltages to the grids of the tubes in the electronic counter. Although there are three separate channels, only two were used. The power supply is capable of applying up to +400 volts DC to the plate circuits of the electronic counter. In addition to this, it supplies 6.3 volts AC to the tube filaments.

The two-tube electronic counter is in the center. It amplifies the narrow, low amplitude pulses from the Geiger tube and makes them suitable to operate the mechanical counter. The mechanical counter is the small object just in front of the electronic counter. It registers each click from the Geiger tube and can be reset to zero after each reading.

The initial pulse is supplied by the Geiger tube in the left foreground. The plastic stand that supports the tube has a shelf on which the sample is placed. The three batteries behind the plastic-cased electronic counter supply 900 volts DC to operate this Geiger tube. A photographic timer clock (borrowed from my father) is the black object at the left. It automatically shuts off the counter at the end of a predetermined time.

Counter Circuit

The Type 1WH Geiger tube, lent to me by the sponsor of my high school physics club, was manufactured by Nucleonics Corporation of America. It is


Average Counts per Minute Above Background
Calibration curve relating counts per minute to micromicrocuries of radium.
Micromicrocuries Radium Standard

Two points are obtained by taking reading with each of 2 radium-standard discs from kit. Both are at same distance from Geiger tube as were samples of milk.

sensitive, at the end pointing downward, to gamma and beta emission. There are two electrodes on the inside, and it is gas-filled. When a gamma or beta ray penetrates the tube, the gas may ionize. If this happens, current will flow for a very short time during the duration of ionization, creating a pulse. The pulse is amplified and elongated so that it will last long enough to operate a mechanical counter.

Since the mechanical counter and associated circuit will record a maximum of about 6 pulses per second, the equipment is limited to a maximum of about 360 counts per minute. For my science project this is entirely satisfactory. The circuit is very stable, making for accurate measurements. An indication of this is the wide range of plate and grid voltages that can be used.

A photographic timer may be used, or the counter may be operated manually, using an ordinary electric clock.

Power Supplies

The plate supply circuit is the usual type of power supply, except that a variac has been connected to the primary coil of the power transformer. This enables complete variation of the direct current output voltage. The power supply uses dry metal rectifiers, connected so there is full wave rectification. The filter, consisting of two choke coils and three electrolytic condensers, converts the pulsating direct current into smoothed direct current.

TAKING THE DATA

The samples were placed on the top shelf of the Geiger tube stand for reading. They were carefully placed directly under the end window of the Geiger tube. The counting apparatus was allowed to run 10 minutes for each reading for each sample. All of the points obtained from the reading were plotted in counts per minute against the number of weeks since the first weekly sample of May 3, 1958. Months were marked off at the top to give a better conception of the calendar date for each sample (*see illustrations on page 26*).

Almost all of the samples had three of these 10-minute readings to improve the statistical accuracy. However, in a few cases additional points were determined to see better the spread of the data. In all cases, at least two background readings of 10 minutes' duration were also taken. One can note that the background readings did not show any systematic trend when plotted on a graph, so it was possible to take an average of all these points. This average was 34 counts per minute.

Because of the fact that the sample and background readings were determined by chance ionization of the Geiger tube due to radioactivity disintegrations, it is necessary to use averaging to determine true trends rather than merely record random fluctuations. All of the readings above the average background for each week were averaged and these weekly averages were again averaged to get the average counts per minute above background at monthly intervals. These data were plotted with average counts per minute above background on the vertical scale and months along the horizontal scale. From this graph one can get a much better understanding of the up and down swings of the radioactivity. One can also note that Washington had a peak in milk radioactivity level in July, 1958.

CALIBRATION OF EQUIPMENT

Without a standard calibration, my readings and curves would not have been of great value. The standard calibration is needed to compare the amount of radiation present from other sources. An inexpensive kit manufactured by Ken Research, Inc., was used. Standards used for my project were 20 and 100 micromicrocuries.

There is another important point in calibration. If enough of a sample is present, the upper part might tend to shield radiation from the lower part. I found that there definitely was some shielding. Because of this, the effective weight of my 3.35 gram sample turned out to be very close to 1.0 gram.

ANALYSIS OF RESULTS

The table on page 26 is a summary of the data thus far attained and some additional data that has been derived from it. The second column lists the counts per minute and micromicrocuries for each monthly average. It was determined that the effective weight of the samples is one gram, and going back to the section on Preparation of Samples, it was found that the samples were concentrated 40 times from the original liquid milk. Therefore, as shown in column 4, it would require 40 grams of milk to produce a sample having an effective weight of one gram. The figures in column 5 were obtained by dividing the number of micromicrocuries for each sample by 40 grams and are expressed in micromicrocuries per gram.

Since other surveys use micromicrocuries per liter (a liter is approximately one quart) rather than per gram, it is convenient to change these readings to that scale. The specific gravity of cow's milk is 1.03. Because the measurements are probably not accurate to three significant figures, it is possible to round off this number to one, which is the same as water. There are 1,000 grams of water in one liter, so to get micromicrocuries per liter in column 6, column 5 is multiplied by 1,000.

These points are plotted on the graph, giving a graph in the units used by the Public Health Service. The Washington *Post and Times Herald* had an article on November 16, 1958, which reported that radioactivity in the air due to atomic weapon tests in the Pacific, during the spring and early summer, reached a peak all over the country in July, 1958. This correlates with my data, for the graph shows that I, too, report a high of 230 micromicrocuries per liter of milk in July, 1958. The graph also shows the radioactivity building up again in January, 1959. The average radioactivity for the whole nine-month period is a little less than 210 micromicrocuries per liter.

For the month of September, 1958, the Public Health Service reported the following total radioactivity figures in micromicrocuries per liter of milk:

Saint Louis, Missouri	469
Fargo, North Dakota	347
Chicago, Illinois	196

Atlanta, Georgia	192
Cincinnati, Ohio	184
New York, New York	180
Spokane, Washington	145
Salt Lake City, Utah	125
Sacramento, California	102
Austin, Texas	101

Notice that Saint Louis had the highest count—469 micromicrocuries per liter—and Austin the lowest—101 micromicrocuries per liter. It is evident that my data agrees with the Public Health Service data, showing that the radioactivity in Washington, D. C., milk was between that in Chicago and Atlanta, and about the same as the radioactivity in Cincinnati and New York. The radioactivity in the milk from Saint Louis and Fargo was much greater than in Washington. Spokane, Salt Lake City, Sacramento, and Austin had appreciably less than Washington.

CONCLUSIONS

1. Each week for 38 weeks I measured the total radioactivity of milk in Washington, D. C., for a nine-month period from May 10, 1958, through January 24, 1959. Neither the U. S. Public Health Service nor the Atomic Energy Commission are making such measurements at Washington, D. C.

2. On the basis of monthly averages of my data, the graph was prepared. This shows the peak radioactivity to be 230 micromicrocuries per liter in July, 1958. This correlates with the fact that radioactive fallout hit a new high in this same month, according to newspaper reports.

3. My measurements indicate a second maximum of 225 micromicrocuries per liter in January, 1959. The Public Health Service also reported a substantial increase in the radioactivity of milk in cities other than Washington around the beginning of 1959.

4. The average total radioactivity of milk in Washington, D. C., for the nine-month period of my measurements was found to be about 210 micromicrocuries per liter.

5. My data fits well with the Public Health Service data showing that the total radioactivity in Washington milk was between that of Chicago and Atlanta, and about the same as Cincinnati and New York.

ACKNOWLEDGMENTS

I would like to acknowledge the help of my father for his suggestions and helpful criticisms. In particular, I wish to thank him for helping me to get the electronic counter functioning properly. I am grateful also to my mother, who took the time to type the final copy of this report, and to my chemistry teacher for her interest and encouragement. My home room teacher, and sponsor of our high school physics club, was very kind to lend me the Geiger tube and stand. Finally I would like to thank our local pharmacist for the use of his chemical balance and our milkman for donating the milk caps.

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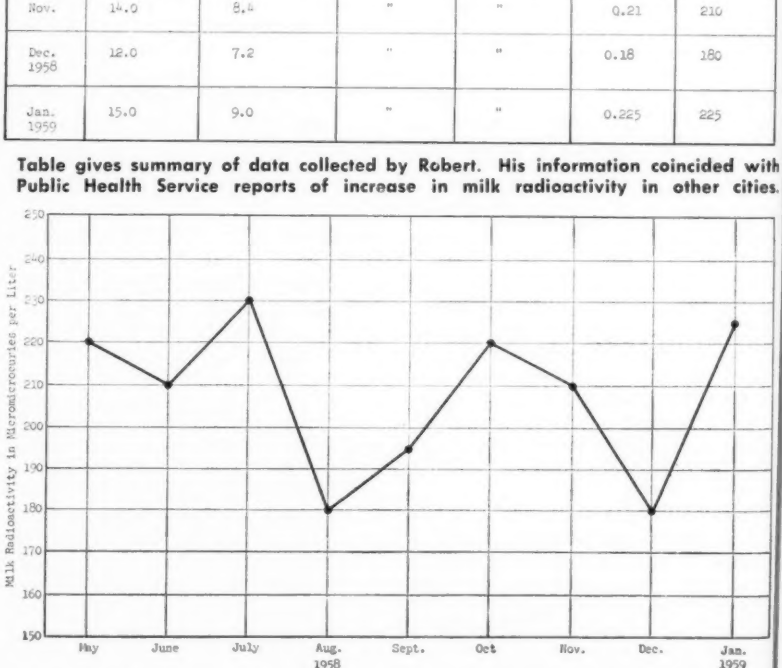
1. *American Institute of Physics Handbook*, McGraw-Hill Book Co., N. Y.
2. Bureau of Naval Personnel, *Basic Electronics*, Navy Training Courses, Navpers 10087, U. S. Government Printing Office, 1955.
3. Van Valkenburgh, Nouger, Neville, *Basic Electronics*, Vol. 2, John F. Rider Publisher, New York, 1955.
4. *Langes Handbook of Chemistry*, Handbook Publishers, Inc., Sandusky, Ohio, 1937, pp. 560.

Column (1)	(2-a)	(2-b)	(3)	(4)	(5)	(6)
Month and Year	Radioactivity of Sample Above Background		Effective Weight of Sample	Weight of Milk to Produce Effective Sample Weighing One Gram	Milk Radioactivity in Micro-microcuries per Gram	Milk Radioactivity in Micro-microcuries per Liter
May 1958	Counts 14.5 per Minute	Micro-8.7 micro-curies	1 Gram	40 Grams	0.22	220
June	14.0	8.4	"	"	0.21	210
July	15.5	9.3	"	"	0.23	230
Aug.	12.0	7.2	"	"	0.18	180
Sept.	13.0	7.8	"	"	0.195	195
Oct.	14.5	8.7	"	"	0.22	220
Nov.	14.0	8.4	"	"	0.21	210
Dec. 1958	12.0	7.2	"	"	0.18	180
Jan. 1959	15.0	9.0	"	"	0.225	225

Table gives summary of data collected by Robert. His information coincided with Public Health Service reports of increase in milk radioactivity in other cities.

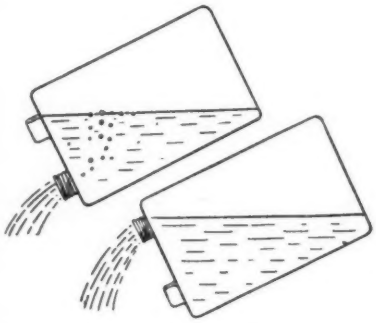


Information in table was plotted on graph. Reports showed that radioactivity due to atomic tests in Pacific during spring and summer hit nationwide peak in July 1958.

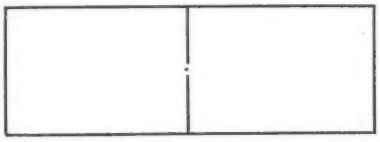
What Happens and Why

By THEODORE BENJAMIN

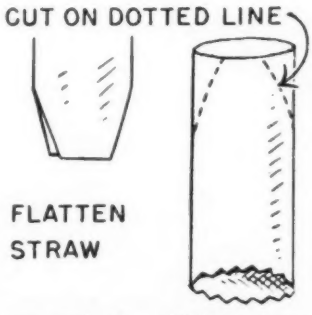
The scientist must describe a phenomenon accurately, and then, on the basis of scientific fact and theory, explain what he sees. Let's see what kind of a scientist you would make. Here are a series of observational experiences which you can try for yourself. In each case you are to describe what happens and explain why. You will probably find that in most cases you and your class will agree on what happens, but the "why" can start some heated arguments.



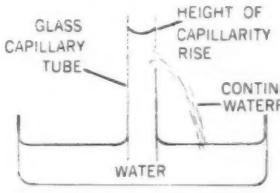
Examine the drawing above. Which method of pouring gasoline (or any other fluid) from the can would you regard as the more efficient? Why?



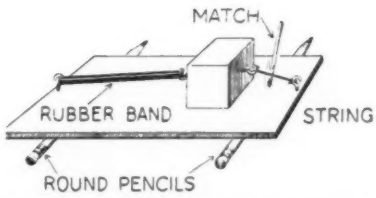
In the rectangle of the figure above color one half blue and the other half red. Then hold the figure at normal reading distance and stare intently at the dot on the line between the two colors. Keep looking at the figure and count slowly to 45. Then look up to a blank wall or the ceiling. What do you see there? Why?



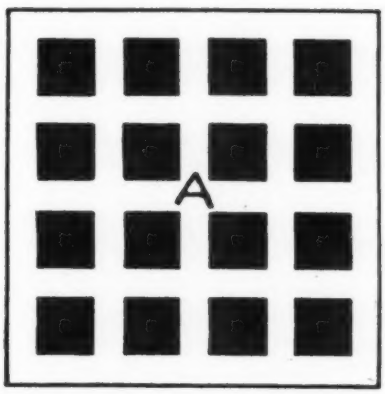
Cut one end of a drinking straw as shown. Flatten the end until there is a narrow space. Put the straw into your mouth so that your lips hold it just back of the flattened portion. Blow through the straw. What makes the sound? Why?



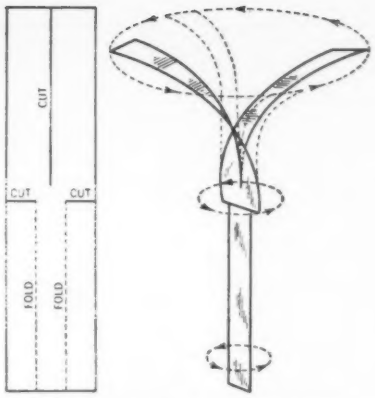
You are probably familiar with the way liquids rise in narrow tubes. This is the phenomenon of capillarity. Suppose you place a glass tube with a small hole in its side upright in a dish of water. If the normal capillarity height to which the water rises is above the hole, will the water continue to flow out of the hole indefinitely? Why?



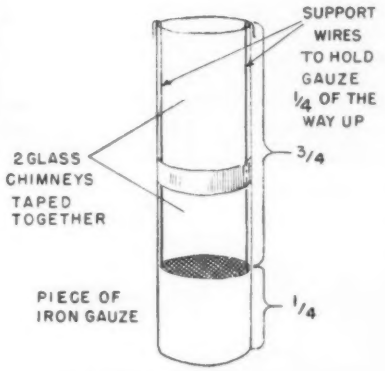
Arrange a block of wood on a small platform of plywood as shown above. Be sure that the rubber band is under tension. What happens when the string is burned with a match? Why?



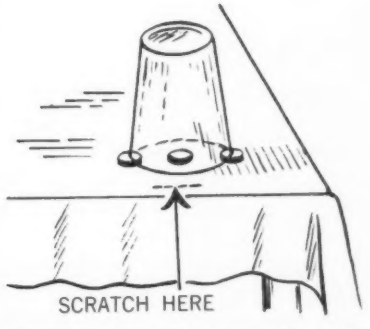
Look at the figure above. Look particularly at the spot marked A. Describe the appearance of the white intersections of the other squares you see. Why do these intersections appear to you as they do?



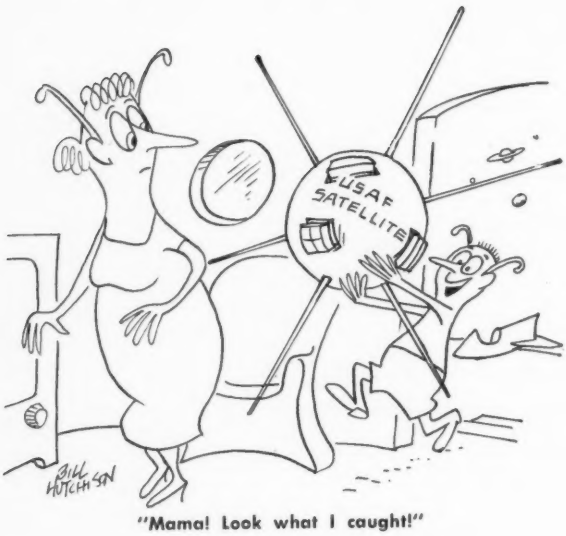
Cut and fold a paper strip as shown in the figure above. Drop the paper, with the narrow end down, from a height of about six feet from the floor. What happens as the paper falls? Why?



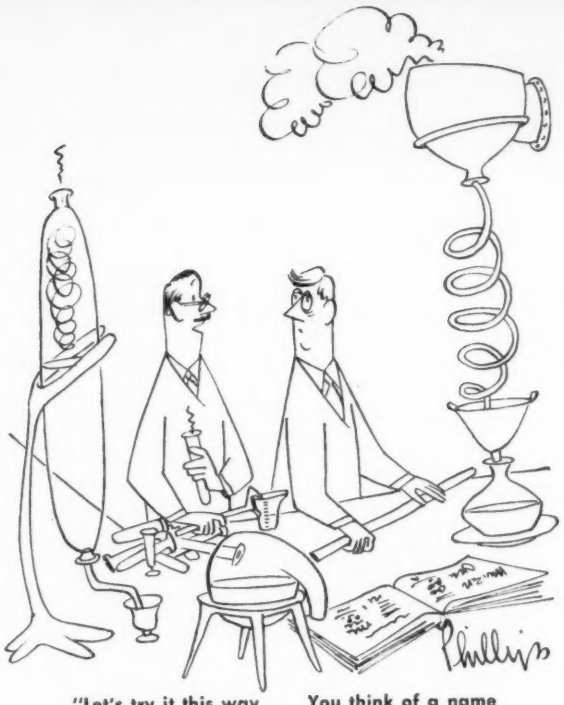
Suspend a piece of iron gauze one-quarter of the way from the bottom of an open glass tube as in the figure above. Heat the iron gauze in a Bunsen flame until it is almost red hot. Remove the glass tube from the Bunsen flame and allow the iron gauze to cool. What vibrates to cause the ear-splitting howl that you hear? Why?



Arrange a glass and three coins as in the figure above. A dime is under the glass while the glass rests on two nickels. Scratch the tablecloth with your fingernail just outside the glass. What happens to the dime? Why?



"Mama! Look what I caught!"



"Let's try it this way . . . You think of a name and I'll discover a new element to fit it."

I WAS A

Teen-Age Electron

Meredith Joan Light
Kenwood Public School
Chicago, Illinois

I wasn't originally an electron, not really, I mean. I was a meson at first. One day (oh, shocking day of all days!) I became an electron.

Boy! Have I had adventures! Some old beta particles were almost shocked out of their charge by some of the things I did.

I've been shot through wires and collected in electroscopes. Once (heh, heh) some buddies and I collected on Democritus. Boy! Did we give him a shock!

Some adventures are even more hair-raising than that. One day, some nut shot me through a vacuum at a piece of lead. I was going pretty fast and it gave me such a jar, I let loose with a couple of X rays. A book was written about it.

I'll never forget the time I almost ran into a positron. We were greatly attracted to each other, but I knew the romance would end in annihilation for us both. One rash youngster ran into her and they met head on. Poor guy, he was so young to be dissipated into energy.

Once they sent one of my old chums (we knew each other when we were mesons) through a crystal and got all upset because he behaved like a wave. So they called all of us electrons waves and wrote some more books about it. Me, of all electrons, a wavicle! It's worse than being mistaken for a photon. Well, who cares what they think. I know whether I'm a wave or a particle and I'm not telling.

Reprinted by permission from *Particle*, a Quarterly. Spring 1959.

Space Detective

(Continued from page 22)

called it a "Rockoon." He also persuaded the Coast Guard to put him and his students aboard an icebreaker bound for Greenland to launch Rockoons for experimental purposes.

They found that cosmic radiation near Newfoundland seemed to be incredibly intense above a height of 30 miles. "There was something wild and wooly going on," Van Allen said later. Although he did not know it, he was on the edge of a great discovery.

Needed: New Instruments

Rockoons had carried the research as high as it could go. Van Allen began to take an interest in satellites. On January 31, 1958, a Jupiter-C rocket put an Explorer I satellite into orbit. It carried instruments designed by Van Allen.

He and his colleagues waited in Iowa City. Soon data from the instruments started to come in. When Explorer I came closer to the Earth, over the U. S., the intensity of the radiation decreased as the altitude decreased. This was expected.

But when the elliptical orbit of Explorer I went farther from the Earth, over South America and South Africa, the radiation count was very low. A low count usually indicated little radiation, but this did not seem correct. Had something gone wrong?

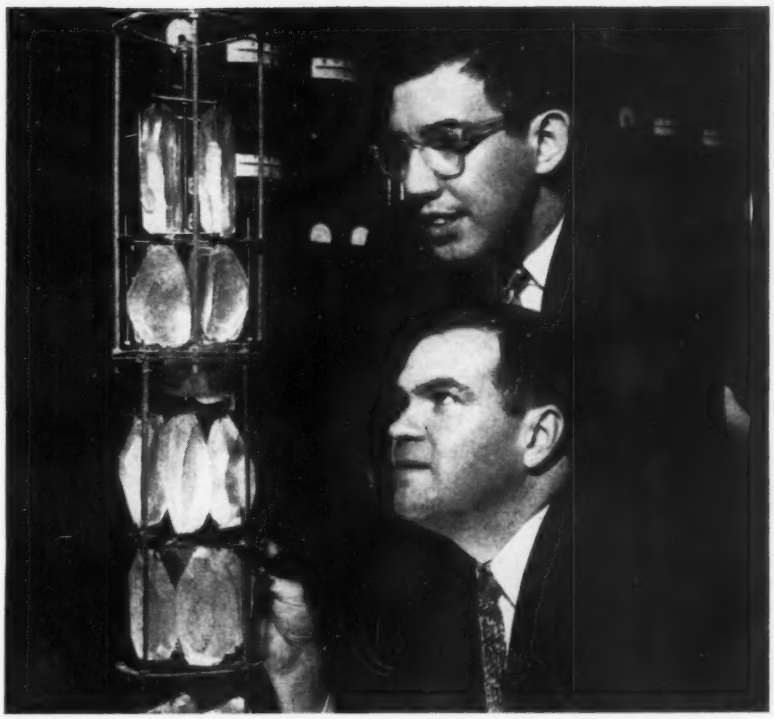
Then Van Allen and his crew realized that the data from Explorer I was incomplete. Since the satellite broadcast a signal continuously, the signal could be picked up only when the satellite came near a ground receiving station. Much of the information over the oceans was lost.

New instruments were needed. A magnetic tape recorder—weighing only eight ounces—was developed. This recorder saved up all the information

(Continued on page 30)

Answers to Crossword Puzzle

(See page 30)



Under extreme pressure, and at high temperature, silica from materials such as ordinary sand can be made to grow into quartz crystals such as these.

GOOD QUARTZ IS HARD TO FIND —SO WE GROW OUR OWN

Wait a minute—isn't quartz something you find in the earth? If anyone "grows" it, it is Mother Nature, and she's been doing it for millions of years.

Well, all quartz *used* to be natural! But Bell Laboratories scientists developed a practical method for growing quartz crystals artificially.

They had to, because quartz is used in a lot of telephone equipment and natural quartz isn't always of the quality needed. You probably know that we can send several telephone conversations at the same time on the same circuit. High-quality quartz crystals help us perform this and many other of the wonders of communication.

Another reason why we needed to grow our own quartz was the fact that most natural quartz comes from abroad, and in time of emergency it might be impossible to get.

Now the Bell System has begun to produce quartz for its own use. This is possible because scientists asked, "Why *can't* we make quartz? Just because nobody ever has before doesn't mean it's impossible!"

That kind of approach in Bell System science and research is constantly helping to improve the telephone service that you and your family enjoy every day.

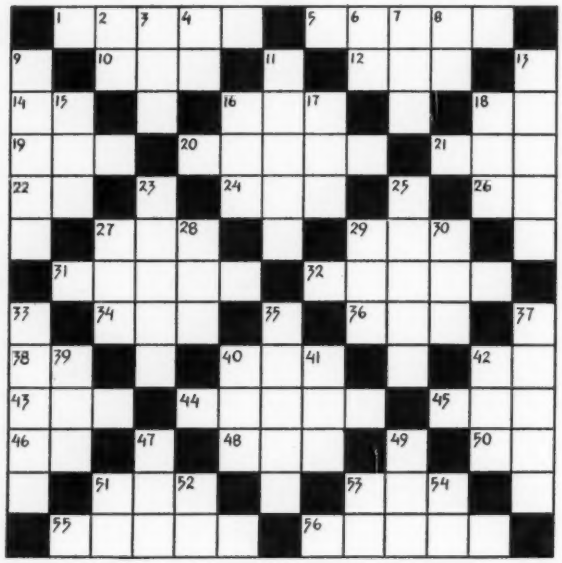
BELL TELEPHONE SYSTEM

Famous Scientists

By Deloris and Elaine Butler, Hopkins (South Carolina) High School

★ Starred words refer to scientists and inventors

Students are invited to submit original crossword puzzles for publication in *Science World*. Each puzzle should be built around one topic in science, such as astronomy, botany, geology, space, electronics, famous scientists, etc. Maximum about 50 words, of which at least 10 must be related to the theme. For each puzzle published we will pay $10. Entries must include puzzle design, definitions, answers on separate sheets, design with answers filled in, and statement by student that the puzzle is original and his own work. Keep a copy as puzzles cannot be returned. Give name, address, school, and grade. Address Puzzle Editor, Science World, 33 West 42nd Street, New York 36, N. Y. Answers to this puzzle are on page 29.



ACROSS

* 1. Discoverer of radium.
5. Big.
10. A star around which the Earth and other plants revolve.
12. Not skinny.
*14. English physician who discovered vaccination (*initials*).
16. A tap.
18. Opposite of yes.
19. Sorrow.
*20. Scottish engineer after whom a unit of power is named (*first name*).
21. Four-wheeled vehicle.
22. Singular form of the verb to be.
24. The fruit of this plant is a legume.
*26. English inventor, the founder of railways (*initials*).
27. Short for taxicab.
29. Friend (*slang*).
31. A tag stating contents, etc.
32. Causing death.
34. Prefix meaning before.
36. Nebraska (*abbr.*).
*38. One of the brothers who made the first airplane (*initials*).
40. Secretary (*abbr.*).
*42. Inventor of cotton gin (*initials*).
43. Kind of tree.
44. Spirits of the dead and gods of the lower world.
45. Avenue (*abbr.*).
46. Kiloliter (*abbr.*).
48. Public Road Administration (*abbr.*).
50. Prefix meaning in.
*51. Inventor of the light bulb (*initials*).
53. Mischievous child.
*55. Swedish inventor of dynamite, Alfred _____.
*56. Inventor of the sewing machine, _____ Howe.

DOWN

2. Our country (*abbr.*).
3. Move rapidly.
* 4. Conceived idea of gravitation (*initials*).
* 6. Built the first commercial steamboat (*initials*).
7. Hearing organ.
8. A preposition.
* 9. Inventor of machine gun, Isaac Newton _____.
11. One who tames.
*13. American inventor of telegraph.
15. Joseph (*abbr.*).
16. To touch lightly.
17. Boston _____ Party.
18. To annoy or bother.
*23. French scientist who studied the habits of insects, Jean Henri _____.
25. To provide a supply of food.
27. Covering for the head.
28. Insect that produces honey.
29. A metal dish.
30. Short for laboratory.
*33. He gave cells their name, Robert _____.
*35. American who discovered method of producing induced current, Joseph _____.
*37. American who invented automatic bottle-blowing machine, Michael J. _____.
39. Walloon (*abbr.*).
40. Juices of a plant.
41. Council of Economics Advisors (*abbr.*).
42. Adam and _____.
47. Singer: _____ Hunter.
49. Broadcast Music Incorporated (*abbr.*).
51. A preposition.
52. Electrical Engineer (*abbr.*).
53. Illinium (*abbr.*).
54. Father (*slang*).

Space Detective

(Continued from page 29)

from one complete orbit of the Earth. In a five-second burst near the receiving station, it transmitted this information to Earth.

On March 28, 1958, Van Allen sat up all night looking over the record of the signals sent from Explorer III. The cosmic radiation count seemed reasonable at low altitudes. When it climbed upward it was also reasonable.

But the count fell to nothing at the highest altitudes. What was the meaning of this?

It was possible that the high flying Geiger tube was being flooded by heavy radiation. This is a weakness of the Geiger tube. If required to count too rapidly it jams.

The amazing conclusion was this: The Earth is surrounded by belts of intense radiation.

Explorer IV carried a shielded Geiger counter to prevent jamming. In December 1958 Pioneer III carried instruments 63,000 miles into space. The data confirmed Van Allen's guess.

From the Explorer and Pioneer shots, Dr. Van Allen found that the radiation forms an enormous reservoir of charged particles. These particles affect the sun's radiation before it reaches Earth—but we do not know how.

Not Satisfied with Theory

The particles also have something to do with the beautiful glow of the northern and southern lights (aurora). Most astronomers and physicists believe the aurora is caused by streams of charged particles that come to the Earth from the sun. These particles are trapped in the Earth's magnetic field. Some are funneled toward the magnetic poles of the Earth. This accounts for the fact that auroras are most frequent near the poles. These particles also have something to do with magnetic storms on Earth.

From the knowledge we now have, it is possible to think of these particles as forming two belts. These have been called Van Allen belts.

But Dr. Van Allen is not satisfied with the present theories about cosmic radiation. This man of science is driven by an urge to probe farther and farther into space. He once said: "The satellite is a natural extension of rockets, which are natural extensions of planes and balloons, which are natural extensions of man's climbing trees and mountains in order to get up higher and thus have a better view."

It all started back in high school, when Jim Van Allen measured cosmic rays at the top of Mount Pleasant.

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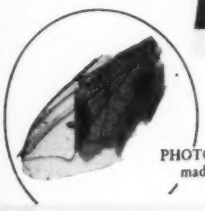

PHOTOMICROGRAPH of a Fly's Wing made with Microscope and Photo Lab (Actual Size 5" diameter)

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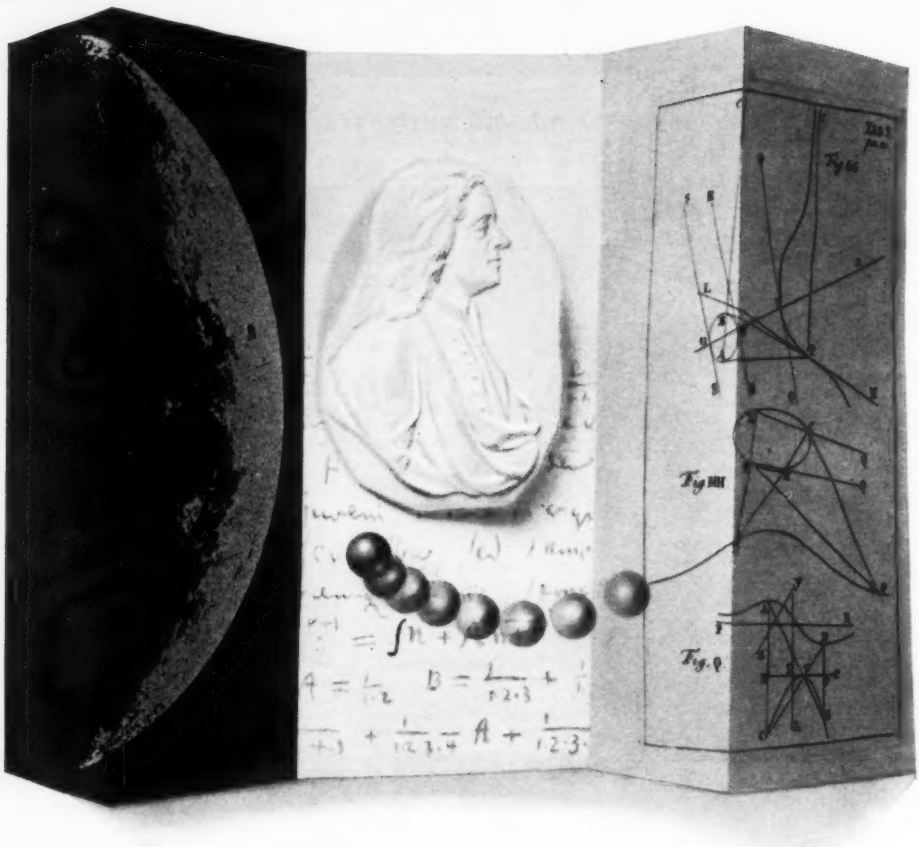
MATHEMATICS SERVING MAN



HOW HIGH, HOW FAST, HOW SOON? When in 1665 the Great Plague closed Britain's Cambridge University young Isaac Newton, who had just received a Bachelor of Arts degree, went home to his isolated farm—and to eighteen months of intense intellectual achievement. This amazing 22-year-old set out to explain the mysterious force that held the moon in its path across the sky. To show that it was the same gravity that pulled an apple to the ground, Newton used an entirely new mathematics of his own invention—the calculus.

Shy and retiring, Newton never even bothered to show anyone his new mathematics for four years, and his work was not published until he was an old man. Soon the calculus was being applied to predicting the motion of everything from the planets to fluids and gases. The calculus remains the cornerstone of applied mathematics in engineering and science: when the first man-carrying satellite soars skyward, Isaac Newton's mathematics will help chart its course through space.

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even a topic such as the classification system is not rigid, and that there are many areas of the classification system still open to investigation.

Teaching Suggestions

This article can be used most profitably to introduce the classification system. To many students, classification is a dull topic. The article makes the student aware of the difficulties biologists encounter in trying to classify the very primitive animals.

The article also gives the teacher the opportunity to discuss careers in the field of biology. It should be pointed out that the biologist is usually a specialist working within a limited field. He is classified according to the type of research he does—protozoologist, physiologist, cytologist, ecologist, taxonomist, morphologist. Opportunities for these specialists in academic and government institutions, museums, and industry should be discussed.

Student projects on this topic may be encouraged. A project on the structure or habits of some of the organisms could be science fair material. Plaster of paris or clay models may be made from the materials illustrating the article.

The excellent cover drawing of chrysamoeba may be used to motivate the class when discussing the classification system. Place it on the blackboard and ask the class—is this a plant or animal? How do you know?

Students interested in art and science should be told of the opportunities in scientific illustrating. The cover design can be used to illustrate this.

Students may do special reports on the World Health Organization's campaign against the tsetse fly. —S. S.

Science Youth Month

October is Science Youth Month. Now is the time to use all of your resources to start the big push for SCIENCE. A good start now will aid you all year round in getting your students interested in various science activities.

Since this month has been given the special designation of Science Youth Month, there is the added incentive for youngsters of having their own month. A good opportunity awaits you. Use it to your best advantage. Here are just a few ideas. Undoubtedly you will have many more.

Sponsor a Science Club if you are not already doing so. A copy of the Sponsor Handbook, issued without cost to sponsors by Science Clubs of America, will answer questions and offer suggestions.

Plan this year's Science Fair, and appoint committees. (If this is your first fair, write Science Service for help in organizing.)

Find a regional or state fair you can join, if you haven't already done so. Thus you make it possible for your winners to compete with other state winners, with the National Fair as the goal.

Request October 15 Science Talent Search examinations from Science Service. Give these to your most promising senior science students. Encourage them to finish their research papers in plenty of time. (Exams must be returned before November 15.)

Ask cooperation from the school faculty in featuring science in mathematics, English, history, hall displays, assembly programs, etc.

Give recognition to top science students, their accomplishments, and plans, in school papers and magazines, as well as news bulletins.

Ask librarians to display new science books and science magazines.

Offer to advise (or to find a professional scientist-advisor) students on individual science projects.

Request student entry materials for the Science Achievement Awards for Students program. These are available from the Future Scientists of America Foundation of the National Science Teachers Association.

Start the ball rolling now toward a Science Youth Year.

STAR '60

Science Teacher Achievement Recognition Awards

Hitch your star to STAR '60.

STAR '60 is designed to stimulate and to recognize superior science instruction in grades 7 through 12. This program is planned to encourage the development of creative ideas, teaching materials, and teaching techniques, and to secure the widest possible dissemination of these.

Science teachers may submit reports on the following types of activities:

1. Teacher demonstration
2. Laboratory exercise
3. Curriculum construction or revision
4. Extra-curricular or co-curricular activity
5. Teacher or pupil projects

Memo from **IBM**

In a way, the Great Plague that swept London in 1665 was responsible for the sudden flowering of Isaac Newton's genius. When Cambridge University closed, young Newton went home. Eighteen months of complete seclusion resulted in three historic achievements: the basic study of light, the universal law of gravitation—and the calculus.

With the calculus (which he called "fluxions") Newton tackled a particularly baffling problem—how to measure values that are continuously changing. An apple falling to the ground or a rocket soaring skyward changes speed continuously. How can you figure the exact velocity at any given point when the speed changes during even the smallest time interval?

Newton's attack was based on the fact that a changing value, calculated for smaller and smaller periods of time or distance, comes closer and closer to a fixed value called a "limit." This was the foundation of what we call "differential" calculus.

Somewhat different were such problems as finding the area of a figure bounded by a curve. Newton also solved this problem by finding a limit, this time of the sum of the areas of ever-narrowing rectangles. This approach, applicable to many things beside areas, we call "integral" calculus.

Though Newton himself declared that he stood on the shoulders of giants, earlier mathematicians had found only limited solutions. Newton developed a general approach that could be used on any problem. And he showed that the two kinds of calculus are actually the inverse of each other.

Newton was more interested in using his "fluxions" to develop the famous laws of gravity and motion than in publishing his work. As a result, another great mathematician discovered the calculus independently. Gottfried Wilhelm Leibnitz of Leipzig developed his calculus—he gave it the name we use—nine years after Newton. Today, Newton's prior invention is recognized, but Leibnitz's system of notation has proved superior and is the one we use.

Since changing quantities are found everywhere in the physical world, calculus has the widest application. Without it neither modern science nor modern engineering would have been possible.

PUT TODAY'S SCIENCE TO WORK IN YOUR CLASSES!

Every two weeks SCIENCE WORLD brings today's exciting world of science and technology into your classroom. Each colorful issue includes fascinating feature articles . . . science news . . . current biographies . . . projects and experiments —correlated with the curriculum in general science, biology, chemistry, earth science, and physics.

And now SCIENCE WORLD includes as a special section in each issue "Tomorrow's Scientists," prepared with the cooperation of the National Science Teachers Association (see pages 23-26).

Taking over where the textbook leaves off, SCIENCE WORLD offers a wide range of appealing materials for the general student as well as the scientifically talented.

Your Teacher Edition includes teaching suggestions for each issue, feature articles, references for further student reading and research.

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6. Science teaching methods
7. Research in science or science education
8. Education program planned and executed jointly by a school and a local community health agency

The sponsors of STAR '60, the National Science Teachers Association and the National Cancer Institute, welcome the collaboration of science teachers and practicing scientists in the development of joint entries. Medallions will be awarded to both teacher and scientist if a cash award is won.

You have an opportunity to put some of your creative ideas, which have worked so well in the classroom, on paper. You will not only be sharing your ideas and techniques with teachers all over the United States. You may also win as much as $1,000.

A circular giving full details may be obtained from NSTA, 1201 16th Street, N. W., Washington 6, D. C.

Put your ideas on paper! Closing date for receipt of entries is December 15, 1959.

Continental Classroom

Early to bed, early to rise, makes a teacher healthy, wealthy, and wise.

We don't know about early risers being healthy or wealthy, but we do know that they can become wise by watching Continental Classroom's Modern Chemistry. This program is to be telecast over the National Broadcasting network 6:30 to 7:00 a.m. (in each time zone) five days weekly from September 28, 1959, through May 27, 1960.

If you have been looking for a way to get additional background in chemistry or to catch up on some of the latest advances without going back to college, this program is perfect.

Continental Classroom is designed primarily for high school teachers of science, but gifted high school and college students, engineers, and interested adults may also view this program with great profit.

If you need a college course for your salary increments, here is a painless way for you to attend college without leaving your easy chair. At least 300 colleges and universities have indicated they plan to offer this course for credit.

Atomic Age Physics, taught last year, will be rerun on the same schedule, 6:00 to 6:30 a.m. It also will be offered for credit. Participating colleges will furnish information concerning registration, prerequisites, tuition, credit, etc. A total of 160 lessons, or 80 per semester, will be given in each subject. Vacation periods will correspond as nearly as possible with those of participating colleges and universities.

A textbook especially prepared for Continental Classroom has been announced by Prentice-Hall, *Modern Chemistry*, by Dr. John F. Baxter and Dr. Luke E. Steiner, in two volumes ($2.50 each). Textbooks for Atomic Age Physics are also available.

Modern Chemistry includes a survey of the fundamental principles of chemistry and a study of recent developments. Structures of chemical species will be stressed, particularly the relationships of these structures to the chemical and physical properties of substances.

The first semester of Atomic Age Physics will be devoted to those aspects of physics necessary to an understanding of nuclear physics. The second semester will deal exclusively with atomic and nuclear physics.

Plan now to take either Modern Chemistry or Atomic Age Physics for college credit. Or, if you prefer, plan now to rise early and soak up chemistry and physics as you sip your morning coffee. Viewing Continental Classroom will not only increase your knowledge but also your effectiveness as a teacher.

Early to bed for Continental Classroom!

Welcome to Instructor Dowd

Francis Dowd, a police detective who was a biologist with the New York City police laboratory, has left the force this month to enter the teaching profession.

The switch will cost him $2,500 a year in pay.

As a member of the police force he earned $6,000. As a biology instructor at Long Island University his salary will be $4,000.

Why the switch? Mr. Dowd feels that "teaching today is a field that has tremendous opportunities and will have even greater ones ten years from now."

His change will give him a chance to do more intensive research in cellular physiology, which is his special field of interest.

Welcome and good luck, instructor Dowd.

Look and Listen

Program Notes on Selected Radio-TV Features

EDITED BY PATRICK AND MARY HAZARD

All times shown are current in Eastern Zone. Programs subject to change. Check local stations before assigning programs to students.

FALL PREVIEW: EDUCATIONAL TELEVISION

The following ETV channels will be carrying the educational television shows described below. The programs will be shown at different times throughout the country so check local stations for dates and times. Stations below are affiliated with the National Educational Television and Radio Center—formerly of Ann Arbor, now of New York City.

WTIQ, Munford, Ala.; WBIQ, Birmingham, Ala.; WAIQ, Andalusia, Ala.; KNME-TV, Albuquerque, N.M.; WGTV, Athens, Ga.; WETV, Atlanta, Ga.; WGBH-TV, Boston, Mass.; WNED-TV, Buffalo, N.Y.; WILL-TV, Champaign-Urbana, Ill.; WUNC-TV, Chapel Hill, N.C.; WTTW, Chicago, Ill.; WCET, Cincinnati, O.; WOSU-TV, Columbus, O.; KOAC-TV, Corvallis, Ore.; KRMA-TV, Denver, Colo.; KDPS-TV, Des Moines, Iowa; WTVS, Detroit, Mich.; WENH-TV, Durham, N.H.; WMSB, East Lansing, Mich.; WUFT, Gainesville, Fla.; KUHT, Houston, Tex.; WJCT, Jacksonville, Fla.; KUON-TV, Lincoln, Neb.; WHA-TV, Madison, Wis.; WKNO-TV, Memphis, Tenn.; WTHS-TV, Miami, Fla.; WMVS-TV, Milwaukee, Wis.; WYES-TV, New Orleans, La.; KETA-TV, Oklahoma City, Okla.; WHYY-TV, Philadelphia, Pa.; WQED, Pittsburgh, Pa.; WQEX, Pittsburgh, Pa.; KVIE, Sacramento, Calif.; KUED, Salt Lake City, Utah; KQED, San Francisco, Calif.; KCTS-TV, Seattle, Wash.; KETC, St. Louis, Mo.; KTCA-TV, St. Paul, Minneapolis, Minn.; WEDU-TV, Tampa, Fla.; KUAT, Tucson, Ariz.; KOED-TV, Tulsa, Okla.

FOR YOUNGER VIEWERS

Friendly Giant: Bob Homme tells stories and teaches youngsters about the things around them.

Magic Doorways: Stories written and told especially for imaginative children.

A Number of Things: Concepts in the natural science field told in story form.

Tales of Poindexter: Fantasy stories acted out by puppets.

Sing Hi, Sing Lo: Folklore of America through dance and song.

Uncle Wonder's Workshop: Simplified principles of the sciences for the preschool child.

What's New: Experimental children's programs utilizing these criteria: that the programs stand for something worthwhile, say something worth knowing, and say it interestingly.

PUBLIC AFFAIRS AND HISTORY

Eastern Wisdom and Modern Life: Themes of Eastern philosophy and their application to modern life.

Escape from the Cage: Report on mental illness.

Hats in the Ring: Political processes in the two major parties.

Heritage: Prominent persons address themselves to subjects in fields where they are particularly qualified.

History with Herb Hake: A site of historical significance is discussed as development of the Great Plains and the Prairies is traced.

Redman's America: Lectures describing important Indian groups.

Search for America: On U.S. values.

Seminar of American Civilization: Max Lerner and Brandeis Univ. students discuss American life and thought.

Twentieth Century Revolutions in World Affairs: Covers ideological, philosophical,

John Forsythe and Dina Merrill co-star in *What Makes Sammy Run?* Sunday, Sept. 27 and Oct. 4, 8 p.m., on NBC-TV.

and practical revolutions since 1900.

U.N. in Transition: Changes in the U.N. brought about by the cold war, nuclear weapons, and fighting in Korea and Middle East.

Young Worlds: Teenage series.

SCIENCE AND EXPLORATION

Astronomy For You: For the adult layman with curiosity about the skies and the universe.

Children Growing: Dr. Maria Piers explains and discusses highlights of normal child development.

Exceptional Child: Problems of exceptional children in adjusting to home, school, and broader social patterns.

Face of the Earth: How the mountains, valleys, and seas of the earth's surface are formed.

Of Science and Scientists: Ideas and techniques that have gone into exploring, understanding, and explaining our universe or in building our civilization.

MUSIC AND THE ARTS

A Time to Dance: Explains serious dance to adults.

Appalachian Spring: Martha Graham's dance composition set to Aaron Copland's symphonic work.

Art and Artists: Great Britain: British artists at work.

Design Workshop: Combines art appreciation with do-it-yourself tips.

Fine Arts Quartet: Encourages appreciation of chamber music.

From Haydn to Hi Fi: A history of chamber music.

Great Plays in Rehearsal: Great plays by representative authors traced from rehearsal to performance.

Of Poets and Poetry: Introduces poetry and the poets who created it.

Two Centuries of Symphony: Analyzes the symphony's four movements as expressed in classical, contemporary, and romantic schools.

Young Audiences: Five special musical groups present great music for young people and introduce youngsters to varied musical instruments.

COMMERCIAL TELEVISION

Wed., Sept. 23, 10:05 p.m. (NBC) except WRCA in New York. In this city, WNYC will carry the program Tuesdays, 8:30 p.m. **Education in the Nation's Service**: "Essential Tasks" with Dr. Robert F. Goheen, president of Princeton Univ.; Sept. 30: "Mr. Wilson and the Nation's Needs" with Archibald MacLeish, Pulitzer Prize-winner.

Thurs., Sept. 24, 7:30 p.m. (NBC-TV) Live coverage of reception for Khrushchev at Soviet Embassy in Washington.

Fri., Sept. 25, 7:30 p.m. (ABC-TV) **Walt Disney Presents**: "Tomorrow the Moon." Cartoons and live action sequences illustrate moon lore and the probable way of interplanetary travel.

Sat., Sept. 26, 1 p.m. (NBC-TV) **Mr. Wizard**: Crystal Structure. (Many local stations will carry this program at a different time, however. In New York City, WRCA-TV will carry it Sundays at 11:30 a.m.) Oct. 3: Sound Frequency. Oct. 10: Crystals Around the House. Oct. 17: Errors in Measurement. Oct. 24: Seeds. Oct. 31: Oxidation Without Air. Nov. 7: Proof of Molecules. Nov. 14: Water Cycle. Nov. 21: How Movies Work. Nov. 28: Waves. Dec. 5: Classification of Plants. Dec. 12: Machines With Senses. Dec. 19: Microscope. Dec. 26: Radioactivity.

8:00 p.m (ABC-TV) **John Gunther's High Road**: Sept. 26: "Inside Cuba." Oct. 3: "Our Most Unusual Ambassador," the story of jazz overseas with Benny Goodman as guest. Oct. 10: "Taming a Mighty River," flood control on the Mississippi. Oct. 17: "Inside Space," a trip into space with a report on the hazards of the first space trip. Oct. 24: "The Lost Civilization," on Mayan culture. Oct. 31: "Wild Elephant Round-up" in India. Nov. 7: "Jamaica." Nov. 14: "The Fisherman's Dream" in Alaska. Nov. 21: "Man Will Find a Way." Nov. 28: "New York—The Day People, The Night People" with Walter Winchell. Dec. 5: "Biography of a Diamond." Dec. 12: "Survival," terns and gulls on a Scandinavian coast.

Sun., Sept. 27, 4:00 p.m. (NBC-TV) Live coverage of Khrushchev's news conference in Washington.

5:30 p.m. (CBS-TV) **The Sword and the Quill**: The Advertising Council and the drive for better schools.

6:30 p.m. (NBC-TV) **Chet Huntley Reporting**: the Khrushchev visit.

7:30 p.m. (CBS-TV) **Sullivan's Travels**: "Invitation to Moscow," Ed Sullivan's 90-minute special.

8:00 p.m. (NBC-TV) **Sunday Showcase**: "What Makes Sammy Run?," dramatization in two parts of the Budd Schulberg novel. Stars Larry Blyden as Sammy Glick, John Forsythe, and Dina Merrill. Study questions next week. Novel is available in Bantam paperback edition.

9:30 p.m. (ABC-TV) **The Splendid American**, a special documentary on three groups of Americans working to help the people of Laos.

10:05 p.m. (CBS) **Invitation to Learning**: "A Pride of Isms." Sept. 27: Optimism, on Voltaire's "Candide." Oct. 4: Communism, on "Selected Correspondence of Marx and Engels."

Mon., Sept. 28, 7:30 p.m. (ABC-TV) **Shirley Temple's Storybook**: "Ali Baba and the Forty Thieves."

8:30 p.m. (CBS-TV) **DuPont Show of the Month**: "Body and Soul" starring Ben Gazzara.

National Radio and TV programs by representatives of religious faiths are listed once each semester.

AO Reports on Teaching with the Microscope

Measurements through the microscope...or how to clock a speeding protozoan

We don't know who he was or when it happened, but the man who made the first measurement and recorded it, probably became the world's first true scientist. Man has been gathering and recording measurement data ever since... virtually nothing escapes his tape measure. The astronomer uses light-years to measure the infinite reaches of the universe; the microscopist uses microns to measure a universe that recedes into infinite smallness; in between lies a vast army of scientists measuring everything on or beneath the earth... indeed, the earth itself... using every conceivable unit of measurement.

The scientific method requires, essentially, the gathering and recording of data... this can be, in itself, an exciting thing. Students can find this to be particularly true as they use the microscope to measure the "unseeable". We hope the following tips on making measurements through the microscope will give your students a new appreciation of this aspect of the scientific method.

MEASUREMENTS THROUGH THE MICROSCOPE

1. ESTIMATE SPECIMEN SIZE

If the field size provided by the objective—eyepiece combination is known, the size of comparatively large specimens can be estimated simply by determining how much of the field the specimen covers. Approximate field sizes provided by the three standard magnifications are as follows:

100X (10X obj., 10X eyepiece) = 1500 microns
430X (43X obj., 10X eyepiece) = 350 microns
970X (97X obj., 10X eyepiece) = 150 microns

To determine field sizes of other low power objective/eyepiece combinations, simply focus on a millimeter scale using oblique illumination (light directed onto surface of scale to reflect off and up into optical system of microscope). You can convert millimeter readings into the microscopists' standard unit of measurement, the micron. One micron is equal to 1/1000 of a millimeter.

2. CROSS-HAIR EYEPIECE

A cross-hair in the eyepiece will mark off the field of view into approximately equal quadrants, thus making it easier to estimate specimen size, particularly if specimen covers less than half the field. Here's how to make a cross-hair disc and insert in eyepiece.

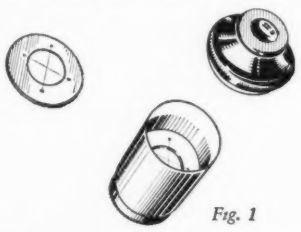

Fig. 1

A. Select a thin washer of proper diameter (approximately ⅞") to fit inside eyepiece. Use human hair (preferably blonde because it is finest) and model airplane cement to fashion a cross-hair over the washer, see fig. 1.

B. Unscrew top lens element from eyepiece. Place washer with cross-hair in eyepiece directly on diaphragm . . . replace top lens element.

3. ESTIMATING SPEED OR MOVEMENTS OF LIVE PROTOZOA, ETC.

Interesting exercises into the realms of relativity and mathematics can be worked out using live protozoa. Observe protozoa under low power and use stop watch to calculate time required for one specimen to traverse entire field or portions of field divided by cross-hair. Microscope magnifies size only, not time. Converting microns per second to the familiar miles per hour results in increased student understanding of the various units of measurement.

4. EYEPIECE MICROMETER

Exact measurements can be made by means of a scale, or micrometer disc, placed in the eyepiece. The divisions in the eyepiece micrometer disc have arbitrary length. The apparent length depends upon the total magnification used. Therefore, before the disc can be used to measure a specimen, it must be calibrated for use with each combination of objective and eyepiece against a stage micrometer. A stage micrometer has divisions of true length. The AO Spencer stage micrometer, Catalog Number 400, has a 2mm scale divided into 200 parts . . . each part measuring .01 mm. Every tenth part on the scale is numbered, see fig. 2. If you want complete information about eyepiece micrometers and stage micrometers just write to: Dept. SW9 American Optical Company, Instrument Division, Buffalo 15, New York.

Fig. 2

PROCEDURE

A. Unscrew top lens of the eyepiece... insert eyepiece micrometer, *ruled side down* on the diaphragm within the eyepiece. Replace top lens.

B. Place stage micrometer on microscope stage...focus sharply with 10X objective. Rotate eyepiece and move stage micrometer until both scales are in juxtaposition along the same axis and both scales are even at one end, see fig. 3. Now count the number of arbitrary divisions of the eyepiece micrometer that fall within a specific true distance on the stage micrometer. In fig. 3,

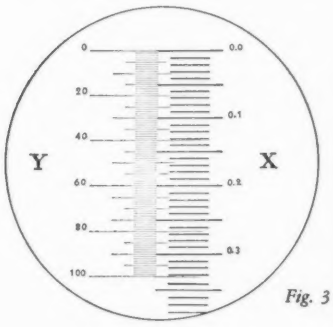

Fig. 3

for example, the first 21 divisions of the eyepiece micrometer (Y) fall within 7 divisions of the stage micrometer (X). We can find the calibration constant (C) simply by dividing the true distance (X) by the number of divisions of the eyepiece micrometer (Y); i.e.:

$$C = \frac{X}{Y}$$

$$C = \frac{7(.01)}{21}$$

C = .003 mm; or 3 microns

Now, using this as an example, if a specimen is measured against the eyepiece micrometer scale and found to span, let us say, 10 divisions, we can determine its size by multiplying the number of divisions it spans by 3 microns, i. e. 30 microns.

NOTE: The eyepiece micrometer must be calibrated at each magnification. Once calibrated, the constant should be noted and then the eyepiece micrometer need not be recalibrated if those same magnifications (and tube length) are used.

$25 For Your Experiment. We will pay $25.00 for each experiment involving either laboratory or stereoscopic microscopes accepted by us for future ads like this one. We're looking for unusual experiments suitable for the high school and junior college level. In the event of similar experiments the one bearing the earliest postmark will be used. The ad containing your experiment will bear your by-line. Write in now!

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